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# OAR Box 1214

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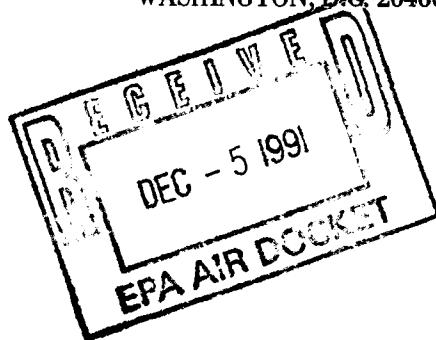
**A-91-46**



A-91-46

IV-E-5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
WASHINGTON, D.C. 20460



OFFICE OF  
AIR AND RADIATION

MEMORANDUM

SUBJECT: Meetings and Telephone Conversations with Employees of Ford Motor Company and Ethyl Corporation Regarding Ethyl/MMT Waiver Submission

FROM: David J. Kortum, Environmental Engineer, Fuels Section

TO: Docket A-91-46 (LE-131)

The purpose of this memorandum is to describe several telephone conversations and meetings which EPA has conducted with staff of the Ford Motor Company and the Ethyl Corporation regarding the Ethyl Corporation's waiver application for MMT.

On October 29, 1991, EPA staff met with Ford Motor Company staff. (A list of participants for all of the meetings/conversations described herein can be found at the end of this memorandum.) The materials presented by Ford at this meeting are described in Ford's October 28, 1991 submission to the docket (letter from David L. Kulp to the EPA Air Docket: Item number IV-D-49).

On October 31, 1991, EPA staff and several representatives of Ethyl Corporation and its counsel and Systems Application Incorporated (SAI) (see list below) held a teleconference call at which EPA staff requested clarification of certain aspects of data sets which were used by Ethyl in the statistical analysis of its data. The response to this request for clarification is attached (Attachment 1).

On November 14, 1991, EPA staff met with Ethyl Corporation staff, including staff of SAI and Ethyl's counsel (see the list below). Ethyl's presentation is summarized in the attached documents which were distributed at the meeting (Attachment 2).

On November 15, 1991, I conducted a telephone call with Mr. Tom Lasley of the Ford Motor Company and asked about data on gaseous emissions collected during particulate testing in Ford's research labs. I also asked for clarification on missing "catalyst interchange" data. The data provided as a result of this inquiry is attached (Attachment 3).

Attachments

## Lists of Attendees

### October 29, 1991 Ford/EPA Meeting

#### Ford:

Tom Lasley  
Dave Kulp  
Dewain Belote

#### EPA:

Mary Smith  
Barry Nussbaum  
John Holley  
Jim Caldwell  
Dave Kortum  
By telephone:  
Rick Rykowski  
Dick Lawrence  
Paul Machiele  
Chris Lindhjem  
Bruce Kolowich  
Jeff Herzog

### October 31, 1991 Telephone Conference

#### Ethyl:

Don Lynam  
Ben Fort  
Dennis Linane  
Jeffrey Smith

#### Hunton and Williams:

Kevin Fast

#### Systems Application Incorporated:

Allison Pollack

#### EPA:

David Kortum  
John Holley

### November 14, 1991 Ford/Ethyl Meeting

#### Ethyl Corporation:

Jeffrey Smith  
Gary ter Haar  
Dennis Linane  
Don Lynam  
Ben Forte

#### SAI:

Allison Pollack  
Ralph Roberson

#### Hunton and Williams:

Bill Brownell  
Kevin Fast

#### EPA:

Mary Smith  
Dick Lawrence  
Bob Kenney  
Barry Nussbaum  
John Holley  
Jim Caldwell  
Dave Kortum  
Dwight Atkinson  
Bruce Kolowich  
Stan Stocker-Edwards

*ATTACHMENT 1**11/6/91/ME***ETHYL CORPORATION****GOVERNMENT RELATIONS**

**Lt. Gen. Jeffrey G. Smith, U.S.A. (Ret.)**  
**Director of Government Relations**

**1155 Fifteenth Street, N.W., Suite 611**  
**Washington, D.C. 20005**  
**Tel (202) 228-4411**  
**Fax (202) 228-1849**

**6 November 1991**

**BY MESSENGER**

**Ms. Mary T. Smith**  
**Director, Field Operations and**  
**Support Division**  
**Office of Mobile Sources**  
**U.S. Environmental Protection Agency**  
**499 South Capitol Street, S.W.**  
**Washington, D.C. 20003**

**Re: Air Docket No. A-91-46**

**Dear Mary:**

Enclosed is information which John Holley and Dave Kortum requested from Alison Pollack of Systems Applications International during a conference call held on October 31, 1991. Among other things, the material concerns the extent to which inclusion of 151 data points (the so-called "third and fourth test" drops) not included in SAI's original statistical analysis of the 48-car test program data affects overall results. You will note from SAI's analysis that inclusion of the 151 data points **reduces** the differences in HC emissions at 50,000 and 75,000 miles predicted by the weighted regression equations when compared to the predictions at the same mileage points of the original SAI statistical analysis.

On a related note, a review of the maintenance logs supplied by Ford as part of Ford's October 29, 1991 submission suggests that Ford might not have supplied all emissions data for its test vehicles to EPA or Ethyl. For example, Ford has not supplied any emissions data for vehicle 306 (an Additive-fueled Explorer) between 55,000 miles and 105,000 miles. Yet the maintenance log for vehicle 306 indicates that vehicle was taken to a Ford facility at 84,940 miles "for emission testing". Similar notations occur for vehicles 315 (a clear fuel Escort) and 316 (an Additive-fueled Escort) at 84,940 miles.

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<sup>1/</sup> In Ford's September 4, 1991 submission to EPA, Ford confirmed that vehicle "306 had duplicate emission tests at 85,000 miles". See R.G. Hurley, et al., The Effect on Emissions and Emission Component Durability by the Fuel Additive Methylcyclopentadienyl Manganese Tricarbonyl, Table 3.

Ms. Mary T. Smith  
6 November 1991  
Page 2

These notations in the maintenance logs appear inconsistent with Ford's statement at the public hearing that it "did not exclude any of the data that was run on these vehicles". (Transcript at page 33). It would be appreciated if the Agency ascertained from Ford if all emission measurements were submitted, and if not, request that Ford submit those data to the docket. Given the small number of test intervals in the Ford test data, emission results for an additional test interval might affect conclusions drawn.

Sincerely,



Enclosure

REC'D BY  
10/17/91 JC

# Systems Applications International

101 Lucas Valley Road San Rafael, CA 94903  
415-507-7100 Facsimile 415-507-7177  
A Division of Clement International Corporation  
Environmental and Health Sciences

## MEMORANDUM

**TO:** Ethyl Corporation  
**FROM:** Alison Pollack and Jonathan Cohen  
**SUBJECT:** Further analysis of Ethyl fleet testing data  
**DATE:** 17 October 1991  
**Reference:** SAI memo dated 2 October 1991

In the referenced memorandum we responded to Ford Motor Company's ("Ford") comments on the generation of the data sets used in Systems Applications International's ("SAI") statistical analysis of the emissions data from Ethyl Corporation's ("Ethyl") 48-car test program. In particular, we categorically disagreed with the suggestion by Ford that SAI "subjectively" created a subset of data for statistical analysis that would generate statistical results favorable to Ethyl, and noted that we had applied the statistical analyses to the data set which, in our view, complied with all applicable regulatory requirements regarding the certification of vehicles under the Clean Air Act and which provided the most "objective" view of the emission test results. We also stated our belief that the conclusions to be drawn from Ethyl's 48-car test program would not change if the statistical tests were repeated using the data not included in SAI's reported analyses. Since then, we have repeated the statistical analyses on a data set containing previously excluded data, and found no difference in the results. These additional analyses were briefly described at our meeting with the Environmental Protection Agency's Office of Mobile Sources on 15 October 1991. The purpose of this memorandum is to document these additional analyses.

For the record, we again repeat the data sets that were generated, the tests that were excluded in each, and the reasons for exclusion of tests:

- |                |  |
|----------------|--|
| <b>ETHYL0S</b> | Data as received from the test laboratories. No tests were excluded, except one test for the replacement vehicle designated D3A: the single test of D3A at 15,554 miles (initial mileage upon receipt). All tests of the replacement vehicle with the old vehicle's emission control system (labeled as D3A) are included. |
| <b>ETHYL1S</b> | 164 zero-mile tests were excluded, per 40 CFR 86.088-28.   |

- ETHYL2S      136 tests that were invalid from an engineering point of view and therefore considered to be "justifiable drops" were excluded.
- ETHYL3S      339 tests preceding unscheduled maintenance were excluded per 40 CFR 86.088-28.
- ETHYL4S      151 tests which were "extra" tests beyond the standard two were deleted.
- ETHYL4S2      102 tests at 50,000 miles after the first two tests before component changes were deleted.

The analyses originally performed by Systems Applications, and incorporated as Appendix 2A to Ethyl's waiver application of 9 May 1990, are based on data set ETHYL4S2, which we believed to be, and still believe to be, that data set which is statistically the most sound, in the sense of having the least potential for biased results.

We repeated all of the adverse effects tests and the Cause or Contribute test on data set ETHYL1S. That is, we included in these new analyses all "extra" tests, all tests preceding unscheduled maintenance, and all tests considered invalid from an engineering point of view. Although there were small changes in some of the numerical quantities estimated (as would, of course, be expected), the conclusions drawn from the 50,000 mile and 75,000 mile analysis of the data set ETHYL1S are identical to those from the data set ETHYL4S2 as described in Appendix 2A to the waiver application. All of the tabulated results, in the same format as presented in Appendix 2A, are available; they are not included here because of their large volume and because the conclusions do not change. Please note that these analyses were performed only to attempt to put to rest Ford's implication that inclusion of previously excluded tests would change the interpretation of Ethyl's data; we still stand behind our original analyses of data set ETHYL4S2.



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A Division of Clement International Corporation  
Environmental and Health Sciences

## MEMORANDUM

**TO:** Dave Kortum and John Holly, EPA/OMS  
**FROM:** Alison Pollack  
**SUBJECT:** Data and analysis requests from Ethyl HiTEC 3000 testing data  
**DATE:** 4 November 1991

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In our conference call of 31 October 1991 with Ethyl Corporation, you requested data listings of average hydrocarbon concentrations and regression analyses of specific data sets based on Ethyl's HiTEC 3000 fleet testing program. The attachments to this memo contain all of the information you requested.

Attachment 1 contains a listing of the average hydrocarbon emissions as plotted in Figures B-49 through B-52 of Appendix 2A (SAI's analyses) to Ethyl's 9 May 1990 waiver application. Averages are listed for each fuel (Howell EEE or HiTEC 3000) within each of the eight models in Ethyl's 48-car fleet. As noted on the listing, these averages are from data set ETHYL4S2, which was the data set used in the majority of SAI's analyses.

Ethyl's protocol called for two FTP tests at each 5,000 mile testing interval for all vehicles. In some cases an additional test (or tests) were performed, if the first two tests resulted in a large difference in emission rates. In creating data set ETHYL4S from data set ETHYL3S, as described on page 12 of SAI's report, 151 such extra tests were deleted. Pages 13 to 15 of SAI's report describe testing associated with component changes at 50,000 miles. Because some significant changes in emissions occurred after component changes, all FTP tests performed after the two standard 50,000 mile interval tests (before component changes) were excluded to create data set ETHYL4S2, which was used in all of SAI's statistical analyses. Therefore, of the 151 tests excluded to create ETHYL4S from ETHYL3S, some are not extra to the first two before component changes. Eighteen tests fall into this category; they are listed and described in Attachment 2. Almost all of the tests listed in Attachment 2 are extra tests performed in addition to the standard two after component changes. The two exceptions are for vehicles D5 and H6; the three tests listed for these two vehicles correspond to extra tests performed in addition to the standard two after unscheduled maintenance. While in general tests after unscheduled maintenance were not excluded from analysis (though tests before unscheduled maintenance were), such tests were excluded in creating data set ETHYL4S2 from ETHYL4S. Because of the complexity of the types of tests performed at the 50,000 mile interval, the software for the creation of data set ETHYL4S2 selected only those 50,000 mile tests coded as preceding

component changes. In addition, all of our software defines the testing interval to be plus or minus 2500 miles of the 5000 mile interval. The single test for vehicle H6 and the two tests for vehicle D5 in Attachment 2 are all extra tests for unscheduled maintenance occurring in the 50,000 mile interval (i.e., 47,500 to 52,500 miles), and were therefore excluded in the creation of ETHYL4S2.

We have now created a new data set, which we refer to as ETHYL3S2, which contains the 1814 tests in data set ETHYL4S2 and the 133 (= 151 - 18) extra tests for that subset of ETHYL4S. We performed the 50,000 mile and 75,000 mile linear regressions on data set ETHYL3S2, the same as had previously been performed on data set ETHYL4S2. Attachments 3 through 6 provide the full set of linear regressions as follows:

Attachment 3	50,000 mile linear regression on data set ETHYL4S2
Attachment 4	50,000 mile linear regression on data set ETHYL3S2
Attachment 5	75,000 mile linear regression on data set ETHYL4S2
Attachment 6	75,000 mile linear regression on data set ETHYL3S2

The first page of each of these four attachments is a summary table of the fitted regression lines with the intercept ("0 miles), the slope (referred to as the deterioration rate), the fitted value at 50,000 miles, and the fitted value at 75,000 miles (in Attachments 5 and 6 only). This page is then followed by eight pages, one per model, of detailed regression output from SAS for the EEE vehicles and then for the HiTEC 3000 vehicles. This detailed output includes the analysis of variance table as you requested. However, a test for a statistically significant change in slope with the addition of the extra tests is a non-trivial test because the two regression equations are highly dependent.

Although we have not performed the statistical comparison of the two sets of regression slopes, one can nonetheless draw somewhat qualitative conclusions based on the standard errors about the regression coefficients, and based on the comparisons of the predictions at 50,000 (and 75,000) miles. The changes in the deterioration rates and the changes in the 50,000 mile and 75,000 mile predictions are all very small, and appear to be within the noise. In virtually all cases the predicted difference between EEE and HiTEC 3000 vehicles is decreased in the ETHYL3S2 analysis from the ETHYL4S2 analysis. In addition, the weighted average results at the bottom of each summary table show that the predicted differences between HiTEC 3000 and EEE decrease with the addition of these 131 tests. In other words, the addition of the extra tests, if anything, is in Ethyl's favor.

## ATTACHMENT 1

Average hydrocarbon emissions (g/mile) from data set ETHYL4S2

Mileage		HC D	HC E	HC F	HC T	HC C	HC G	HC H	HC I
EEE	1	0.281	0.099	0.168	0.189	0.123	0.101	0.182	0.173
EEE	5	0.304	0.131	0.246	0.231	0.143	0.113	0.190	0.170
EEE	10	0.334	0.155	0.331	0.245	0.166	0.120	0.223	0.171
EEE	15	0.373	0.148	0.386	0.278	0.158	0.106	0.230	0.190
EEE	20	0.441	0.156	0.399	0.280	0.190	0.136	0.277	0.184
EEE	25	0.454	0.158	0.480	0.305	0.179	0.140	0.281	0.223
EEE	30	0.570	0.171	0.583	0.302	0.175	0.146	0.294	0.175
EEE	35	0.575	0.163	0.555	0.335	0.206	0.136	0.321	0.191
EEE	40	0.554	0.196	0.586	0.418	0.175	0.139	0.300	0.176
EEE	45	0.639	0.233	0.688	0.402	0.184	0.138	0.312	0.178
EEE	50	0.605	0.212	0.729	0.446	0.183	0.123	0.345	0.195
EEE	55	0.758	0.218	0.564	0.392	0.198	0.146	0.390	0.183
EEE	60	0.705	0.245	0.593	0.366	0.181	0.130	0.420	0.187
EEE	65	0.696	0.294	0.580	0.457	0.177	0.148	0.424	0.181
EEE	70	0.594	0.223	0.583	0.398	0.208	0.164	0.378	0.214
EEE	75	0.678	0.246	0.476	0.433	0.202	0.161	0.389	0.190
HITEC	1	0.279	0.104	0.167	0.207	0.129	0.100	0.168	0.162
HITEC	5	0.318	0.161	0.253	0.257	0.159	0.117	0.208	0.174
HITEC	10	0.354	0.181	0.349	0.297	0.197	0.130	0.209	0.183
HITEC	15	0.421	0.190	0.405	0.291	0.204	0.142	0.262	0.212
HITEC	20	0.519	0.202	0.422	0.328	0.239	0.172	0.265	0.187
HITEC	25	0.514	0.184	0.458	0.346	0.214	0.173	0.258	0.193
HITEC	30	0.625	0.195	0.606	0.372	0.220	0.179	0.298	0.200
HITEC	35	0.645	0.191	0.576	0.398	0.256	0.182	0.275	0.191
HITEC	40	0.635	0.234	0.569	0.437	0.239	0.182	0.296	0.194
HITEC	45	0.646	0.193	0.611	0.431	0.228	0.171	0.351	0.203
HITEC	50	0.721	0.194	0.693	0.454	0.220	0.153	0.337	0.194
HITEC	55	0.655	0.210	0.555	0.429	0.226	0.169	0.398	0.194
HITEC	60	0.649	0.239	0.630	0.410	0.205	0.169	0.481	0.194
HITEC	65	0.742	0.267	0.616	0.411	0.212	0.189	0.460	0.200
HITEC	70	0.578	0.226	0.599	0.398	0.254	0.186	0.408	0.216
HITEC	75	0.621	0.241	0.613	0.400	0.235	0.197	0.412	0.216

## ATTACHMENT 2

## Tests NOT To Be Added back to ETHYL4S2

OBS	Model	Vehicle ID	Fuel	Mileage	HC (g/mi)	CO (g/mi)	NOx (g/mi)
1	D	D4	HT3	50,166	0.581	3.490	0.417
2	D	D4	HT3	50,184	0.607	3.619	0.384
3	D	D5	HT3	48,433	0.924	4.960	0.441
4	D	D5	HT3	48,444	0.796	4.617	0.404
5	E	E2	EEE	50,181	0.323	7.928	0.531
6	F	F5	EEE	50,118	0.596	2.253	0.978
7	F	F5	EEE	50,166	0.618	1.939	1.037
8	G	G1	EEE	51,110	0.137	3.234	0.395
9	G	G3	HT3	51,110	0.183	2.248	0.390
10	G	G4	EEE	51,104	0.132	2.194	0.365
11	G	G5	HT3	51,132	0.283	2.192	0.357
12	G	G6	HT3	51,118	0.169	2.350	0.369
13	H	H6	HT3	50,688	0.428	4.908	0.388
14	I	I1	EEE	50,379	0.167	2.768	0.438
15	I	I2	HT3	50,278	0.212	2.401	0.301
16	I	I4	HT3	50,431	0.158	2.329	0.311
17	I	I5	EEE	50,386	0.176	2.240	0.428
18	I	I6	HT3	50,326	0.182	2.123	0.604

## ATTACHMENT 3

**Ethy1 Corporation HiTEC 3000 Fleet Testing Program**  
**0-50k Data Analyzed**

**Fitted Regression Lines**  
**Data Set ETHYL4S2**  
**Pollutant Hydrocarbons**

Model	Fuel	0 Miles (g/mi)	50k Miles (g/mi)	Deterioration Rate(a) (rate/10,000 mi)
D	HT3	0.2895	0.7469	0.0915
	EEE	0.2743	0.6615	0.0774
E	HT3	0.1512	0.2181	0.0134
	EEE	0.1128	0.2170	0.0208
F	HT3	0.2270	0.7149	0.0976
	EEE	0.2010	0.7432	0.1084
T	HT3	0.2271	0.4663	0.0478
	EEE	0.1896	0.4273	0.0476
C	HT3	0.1666	0.2524	0.0172
	EEE	0.1448	0.1967	0.0104
G	HT3	0.1221	0.1895	0.0135
	EEE	0.1121	0.1444	0.0064
H	HT3	0.1836	0.3501	0.0333
	EEE	0.1895	0.3465	0.0314
I	HT3	0.1771	0.2047	0.0055
	EEE	0.1771	0.1894	0.0025
Wtd Ave (b)	HT3	0.1875	0.3657	0.0356
	EEE	0.1731	0.3484	0.0351

## Notes:

- a. The deterioration rate is the rate of increase per 10,000 miles (slope of the regression line).
- b. The weights for the weighted averages are proportional to 1988 sales figures.

Systems Applications Int.  
 November 4, 1991

Ethyl Corporation HiTEC 3000 Fleet Testing Program  
0-50k Data Analyzed  
Data Set ETHYL4S2

1

----- MODEL=C FUEL=EEE -----

Model: MODEL1  
Dependent Variable: HC                    HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.01764	0.01764	26.009	0.0001
Error	70	0.04747	0.00068		
C Total	71	0.06511			
Root MSE		0.02604	R-square	0.2709	
Dep Mean		0.17129	Adj R-sq	0.2605	
C.V.		15.20343			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.144770	0.00603848	23.975	0.0001
MILES	1	0.010389	0.00203711	5.100	0.0001
----- MODEL=C FUEL=HT3 -----					

Model: MODEL1  
Dependent Variable: HC                    HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.04823	0.04823	40.027	0.0001
Error	72	0.08675	0.00120		
C Total	73	0.13498			
Root MSE		0.03471	R-square	0.3573	
Dep Mean		0.21051	Adj R-sq	0.3484	
C.V.		16.48898			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.166556	0.00803473	20.729	0.0001
MILES	1	0.017166	0.00271325	6.327	0.0001

Systems Applications Int.  
November 4, 1991

Ethyl Corporation HiTEC 3000 Fleet Testing Program  
0-50k Data Analyzed  
Data Set ETHYL4S2

2

----- MODEL=D FUEL=EEE -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

## Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.67048	0.67048	267.532	0.0001
Error	46	0.11528	0.00251		
C Total	47	0.78577			
Root MSE		0.05006	R-square	0.8533	
Dep Mean		0.47531	Adj R-sq	0.8501	
C.V.		10.53239			

## Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.274307	0.01425600	19.242	0.0001
MILES	1	0.077441	0.00473457	16.356	0.0001

----- MODEL=D FUEL=HT3 -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

## Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	1.40237	1.40237	304.781	0.0001
Error	70	0.32209	0.00460		
C Total	71	1.72445			
Root MSE		0.06783	R-square	0.8132	
Dep Mean		0.52669	Adj R-sq	0.8106	
C.V.		12.87887			

## Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.289458	0.01576598	18.360	0.0001
MILES	1	0.091484	0.00524026	17.458	0.0001

Systems Applications Int.  
November 4, 1991

Ethyl Corporation HiTEC 3000 Fleet Testing Program  
0-50k Data Analyzed  
Data Set ETHYL4S2

3

----- MODEL=E FUEL=EEE -----

Model: MODEL1  
Dependent Variable: HC                    HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.07118	0.07118	61.154	0.0001
Error	70	0.08148	0.00116		
C Total	71	0.15266			
Root MSE		0.03412	R-square	0.4663	
Dep Mean		0.16600	Adj R-sq	0.4587	
C.V.		20.55272			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.112765	0.00790617	14.263	0.0001
MILES	1	0.020847	0.00266586	7.820	0.0001

----- MODEL=E FUEL=HT3 -----

Model: MODEL1  
Dependent Variable: HC                    HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.02931	0.02931	36.485	0.0001
Error	70	0.05624	0.00080		
C Total	71	0.08555			
Root MSE		0.02834	R-square	0.3426	
Dep Mean		0.18536	Adj R-sq	0.3332	
C.V.		15.29166			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.151179	0.00657146	23.005	0.0001
MILES	1	0.013393	0.00221725	6.040	0.0001

Systems Applications Int.  
November 4, 1991

Ethyl Corporation HiTEC 3000 Fleet Testing Program  
0-50k Data Analyzed  
Data Set ETHYL4S2

4

----- MODEL=F FUEL=EEE -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	1.92144	1.92144	430.920	0.0001
Error	70	0.31212	0.00446		
C Total	71	2.23357			
Root MSE		0.06678	R-square	0.8603	
Dep Mean		0.47775	Adj R-sq	0.8583	
C.V.		13.97701			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.200961	0.01548279	12.980	0.0001
MILES	1	0.108448	0.00522425	20.759	0.0001

----- MODEL=F FUEL=HT3 -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	1.55828	1.55828	474.803	0.0001
Error	70	0.22974	0.00328		
C Total	71	1.78802			
Root MSE		0.05729	R-square	0.8715	
Dep Mean		0.47604	Adj R-sq	0.8697	
C.V.		12.03432			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.227009	0.01327403	17.102	0.0001
MILES	1	0.097582	0.00447830	21.790	0.0001

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----- MODEL=G FUEL=EEE -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.00679	0.00679	17.258	0.0001
Error	70	0.02754	0.00039		
C Total	71	0.03433			
Root MSE		0.01984	R-square	0.1978	
Dep Mean		0.12858	Adj R-sq	0.1863	
C.V.		15.42580			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.112131	0.00459874	24.383	0.0001
MILES	1	0.006444	0.00155120	4.154	0.0001

----- MODEL=G FUEL=HT3 -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.02972	0.02972	43.296	0.0001
Error	70	0.04804	0.00069		
C Total	71	0.07776			
Root MSE		0.02620	R-square	0.3822	
Dep Mean		0.15651	Adj R-sq	0.3733	
C.V.		16.73832			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.122096	0.00607391	20.102	0.0001
MILES	1	0.013477	0.00204823	6.580	0.0001

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----- MODEL=H FUEL=EEE -----

Model: MODEL1  
Dependent Variable: HC                    HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.16415	0.16415	170.461	0.0001
Error	72	0.06933	0.00096		
C Total	73	0.23348			
Root MSE		0.03103	R-square	0.7030	
Dep Mean		0.27073	Adj R-sq	0.6989	
C.V.		11.46226			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.189514	0.00719086	26.355	0.0001
MILES	1	0.031395	0.00240463	13.056	0.0001

----- MODEL=H FUEL=HT3 -----

Model: MODEL1  
Dependent Variable: HC                    HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.18206	0.18206	99.716	0.0001
Error	72	0.13145	0.00183		
C Total	73	0.31351			
Root MSE		0.04273	R-square	0.5807	
Dep Mean		0.26923	Adj R-sq	0.5749	
C.V.		15.87078			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.183629	0.00990735	18.535	0.0001
MILES	1	0.033290	0.00333378	9.986	0.0001

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----- MODEL=I FUEL=EEE -----

**Model: MODEL1**

**Dependent Variable: HC**

**HC Composite Emissions (g/mi)**

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.00099	0.00099	1.251	0.2671
Error	70	0.05540	0.00079		
C Total	71	0.05639			
Root MSE		0.02813	R-square	0.0176	
Dep Mean		0.18336	Adj R-sq	0.0035	
C.V.		15.34237			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.177079	0.00652181	27.152	0.0001
MILES	1	0.002460	0.00219963	1.119	0.2671

----- MODEL=I FUEL=HT3 -----

**Model: MODEL1**

**Dependent Variable: HC**

**HC Composite Emissions (g/mi)**

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.00520	0.00520	8.053	0.0059
Error	72	0.04652	0.00065		
C Total	73	0.05173			
Root MSE		0.02542	R-square	0.1006	
Dep Mean		0.19161	Adj R-sq	0.0881	
C.V.		13.26630			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.177108	0.00590244	30.006	0.0001
MILES	1	0.005515	0.00194324	2.838	0.0059

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----- MODEL=T FUEL=EEE -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.36925	0.36925	312.368	0.0001
Error	70	0.08275	0.00118		
C Total	71	0.45199			
Root MSE		0.03438	R-square	0.8169	
Dep Mean		0.31089	Adj R-sq	0.8143	
C.V.		11.05908			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.189553	0.00797180	23.778	0.0001
MILES	1	0.047551	0.00269043	17.674	0.0001

----- MODEL=T FUEL=HT3 -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.37248	0.37248	313.997	0.0001
Error	70	0.08304	0.00119		
C Total	71	0.45552			
Root MSE		0.03444	R-square	0.8177	
Dep Mean		0.34915	Adj R-sq	0.8151	
C.V.		9.86452			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.227085	0.00799565	28.401	0.0001
MILES	1	0.047833	0.00269941	17.720	0.0001

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## ATTACHMENT 4

**Ethyl Corporation HiTEC 3000 Fleet Testing Program  
0-50k Data Analyzed**

**Fitted Regression Lines  
Data Set ETHYL3S2  
Pollutant Hydrocarbons**

<b>Model</b>	<b>Fuel</b>	<b>0</b>	<b>50k</b>	<b>Deterioration</b>
		<b>Miles (g/mi)</b>	<b>Miles (g/mi)</b>	<b>Rate(a) (rate/10,000 mi)</b>
<b>D</b>	HT3	<b>0.2928</b>	<b>0.7372</b>	<b>0.0889</b>
	EEE	<b>0.2735</b>	<b>0.6635</b>	<b>0.0780</b>
<b>E</b>	HT3	<b>0.1515</b>	<b>0.2175</b>	<b>0.0132</b>
	EEE	<b>0.1118</b>	<b>0.2194</b>	<b>0.0215</b>
<b>F</b>	HT3	<b>0.2322</b>	<b>0.7060</b>	<b>0.0948</b>
	EEE	<b>0.2015</b>	<b>0.7409</b>	<b>0.1079</b>
<b>T</b>	HT3	<b>0.2247</b>	<b>0.4697</b>	<b>0.0490</b>
	EEE	<b>0.1890</b>	<b>0.4287</b>	<b>0.0479</b>
<b>C</b>	HT3	<b>0.1719</b>	<b>0.2477</b>	<b>0.0152</b>
	EEE	<b>0.1475</b>	<b>0.1943</b>	<b>0.0094</b>
<b>G</b>	HT3	<b>0.1221</b>	<b>0.1895</b>	<b>0.0135</b>
	EEE	<b>0.1104</b>	<b>0.1473</b>	<b>0.0074</b>
<b>H</b>	HT3	<b>0.1833</b>	<b>0.3518</b>	<b>0.0337</b>
	EEE	<b>0.1885</b>	<b>0.3479</b>	<b>0.0319</b>
<b>I</b>	HT3	<b>0.1800</b>	<b>0.2034</b>	<b>0.0047</b>
	EEE	<b>0.1770</b>	<b>0.1885</b>	<b>0.0023</b>
<b>Wtd Ave (b)</b>		<b>HT3</b>	<b>0.1890</b>	<b>0.3642</b>
		<b>EEE</b>	<b>0.1729</b>	<b>0.3488</b>

**Notes:**

- a. The deterioration rate is the rate of increase per 10,000 miles (slope of the regression line).
- b. The weights for the weighted averages are proportional to 1988 sales figures.

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Data Set ETHYL3S2

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----- MODEL=C FUEL=EEE -----

Model: MODEL1  
Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.01499	0.01499	20.138	0.0001
Error	77	0.05731	0.00074		
C Total	78	0.07230			
Root MSE		0.02728	R-square	0.2073	
Dep Mean		0.17178	Adj R-sq	0.1970	
C.V.		15.88112			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.147489	0.00622349	23.699	0.0001
MILES	1	0.009369	0.00208769	4.488	0.0001

----- MODEL=C FUEL=HT3 -----

Model: MODEL1  
Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.04346	0.04346	35.752	0.0001
Error	89	0.10819	0.00122		
C Total	90	0.15165			
Root MSE		0.03487	R-square	0.2866	
Dep Mean		0.21268	Adj R-sq	0.2786	
C.V.		16.39335			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.171932	0.00773321	22.233	0.0001
MILES	1	0.015158	0.00253506	5.979	0.0001

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Data Set ETHYL3S2

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----- MODEL=D FUEL=EEE -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.70205	0.70205	283.442	0.0001
Error	47	0.11641	0.00248		
C Total	48	0.81846			
Root MSE		0.04977	R-square	0.8578	
Dep Mean		0.47904	Adj R-sq	0.8547	
C.V.		10.38913			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.273535	0.01412613	19.364	0.0001
MILES	1	0.078001	0.00463305	16.836	0.0001

----- MODEL=D FUEL=HT3 -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	1.47694	1.47694	328.786	0.0001
Error	78	0.35038	0.00449		
C Total	79	1.82732			
Root MSE		0.06702	R-square	0.8083	
Dep Mean		0.53698	Adj R-sq	0.8058	
C.V.		12.48161			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.292797	0.01541084	18.999	0.0001
MILES	1	0.088888	0.00490215	18.132	0.0001

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0-50k Data Analyzed  
Data Set ETHYL3S2

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----- MODEL=E FUEL=EEE -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.07772	0.07772	65.937	0.0001
Error	72	0.08487	0.00118		
C Total	73	0.16258			
Root MSE		0.03433	R-square	0.4780	
Dep Mean		0.16747	Adj R-sq	0.4708	
C.V.		20.50002			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.111807	0.00793241	14.095	0.0001
MILES	1	0.021525	0.00265085	8.120	0.0001

----- MODEL=E FUEL=HT3 -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.02985	0.02985	37.914	0.0001
Error	72	0.05668	0.00079		
C Total	73	0.08653			
Root MSE		0.02806	R-square	0.3449	
Dep Mean		0.18593	Adj R-sq	0.3358	
C.V.		15.09081			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.151548	0.00646699	23.434	0.0001
MILES	1	0.013199	0.00214358	6.157	0.0001

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**0-50k Data Analyzed**  
**Data Set ETHYL3S2**

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----- MODEL=F FUEL=EEE -----

**Model: MODEL1**  
**Dependent Variable: HC**      **HC Composite Emissions (g/mi)**

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	2.24448	2.24448	508.126	0.0001
Error	78	0.34454	0.00442		
C Total	79	2.58902			
Root MSE		0.06646	R-square	0.8669	
Dep Mean		0.48995	Adj R-sq	0.8652	
C.V.		13.56501			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.201468	0.01479855	13.614	0.0001
MILES	1	0.107877	0.00478566	22.542	0.0001

----- MODEL=F FUEL=HT3 -----

**Model: MODEL1**  
**Dependent Variable: HC**      **HC Composite Emissions (g/mi)**

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	1.65025	1.65025	505.465	0.0001
Error	76	0.24813	0.00326		
C Total	77	1.89838			
Root MSE		0.05714	R-square	0.8693	
Dep Mean		0.48408	Adj R-sq	0.8676	
C.V.		11.80363			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.232182	0.01293779	17.946	0.0001
MILES	1	0.094772	0.00421536	22.483	0.0001

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----- MODEL=G FUEL=EEE -----

Model: MODEL1  
Dependent Variable: HC                    HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.00926	0.00926	19.855	0.0001
Error	72	0.03358	0.00047		
C Total	73	0.04284			
Root MSE		0.02160	R-square	0.2162	
Dep Mean		0.12922	Adj R-sq	0.2053	
C.V.		16.71279			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.110422	0.00490848	22.496	0.0001
MILES	1	0.007385	0.00165725	4.456	0.0001

----- MODEL=G FUEL=HT3 -----

Model: MODEL1  
Dependent Variable: HC                    HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.02972	0.02972	43.296	0.0001
Error	70	0.04804	0.00069		
C Total	71	0.07776			
Root MSE		0.02620	R-square	0.3822	
Dep Mean		0.15651	Adj R-sq	0.3733	
C.V.		16.73832			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.122096	0.00607391	20.102	0.0001
MILES	1	0.013477	0.00204823	6.580	0.0001

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----- MODEL=H FUEL=EEE -----

**Model: MODEL1**

**Dependent Variable: HC**

**HC Composite Emissions (g/mi)**

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.17690	0.17690	171.776	0.0001
Error	80	0.08238	0.00103		
C Total	81	0.25928			
Root MSE		0.03209	R-square	0.6823	
Dep Mean		0.27287	Adj R-sq	0.6783	
C.V.		11.76060			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.188530	0.00734603	25.664	0.0001
MILES	1	0.031865	0.00243129	13.106	0.0001

----- MODEL=H FUEL=HT3 -----

**Model: MODEL1**

**Dependent Variable: HC**

**HC Composite Emissions (g/mi)**

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.21431	0.21431	115.613	0.0001
Error	82	0.15200	0.00185		
C Total	83	0.36631			
Root MSE		0.04305	R-square	0.5850	
Dep Mean		0.27471	Adj R-sq	0.5800	
C.V.		15.67235			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.183328	0.00971104	18.878	0.0001
MILES	1	0.033687	0.00313302	10.752	0.0001

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Data Set ETHYL3S2

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----- MODEL=I FUEL=EEE -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.00091	0.00091	1.228	0.2714
Error	75	0.05571	0.00074		
C Total	76	0.05662			
Root MSE		0.02725	R-square	0.0161	
Dep Mean		0.18299	Adj R-sq	0.0030	
C.V.		14.89402			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.176982	0.00624672	28.332	0.0001
MILES	1	0.002314	0.00208792	1.108	0.2714

----- MODEL=I FUEL=HT3 -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.00406	0.00406	6.202	0.0148
Error	82	0.05367	0.00065		
C Total	83	0.05773			
Root MSE		0.02558	R-square	0.0703	
Dep Mean		0.19239	Adj R-sq	0.0590	
C.V.		13.29739			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.179972	0.00571557	31.488	0.0001
MILES	1	0.004681	0.00187990	2.490	0.0148

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----- MODEL=T FUEL=EEE -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.42054	0.42054	360.511	0.0001
Error	75	0.08749	0.00117		
C Total	76	0.50803			
Root MSE		0.03415	R-square	0.8278	
Dep Mean		0.31429	Adj R-sq	0.8255	
C.V.		10.86729			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.188985	0.00766158	24.667	0.0001
MILES	1	0.047937	0.00252472	18.987	0.0001

----- MODEL=T FUEL=HT3 -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.44387	0.44387	380.427	0.0001
Error	77	0.08984	0.00117		
C Total	78	0.53372			
Root MSE		0.03416	R-square	0.8317	
Dep Mean		0.35053	Adj R-sq	0.8295	
C.V.		9.74467			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.224651	0.00751148	29.908	0.0001
MILES	1	0.049014	0.00251293	19.505	0.0001

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## ATTACHMENT 5

**Ethyl Corporation HiTEC 3000 Fleet Testing Program  
0-75k Data Analyzed**

**Fitted Regression Lines  
Data Set ETHYL4S2  
Pollutant Hydrocarbons**

Model	Fuel	0 Miles (g/mi)	50k Miles (g/mi)	75k Miles (g/mi)	Deterioration Rate(a) (rate/10,000 mi)
<b>D</b>	HT3	<b>0.3785</b>	<b>0.6227</b>	<b>0.7449</b>	<b>0.0489</b>
	EEE	0.3167	0.6139	0.7625	0.0594
<b>E</b>	HT3	<b>0.1518</b>	<b>0.2179</b>	<b>0.2510</b>	<b>0.0132</b>
	EEE	0.1149	0.2157	0.2662	0.0202
<b>F</b>	HT3	<b>0.3113</b>	<b>0.5877</b>	<b>0.7259</b>	<b>0.0553</b>
	EEE	0.3174	0.5715	0.6985	0.0508
<b>T</b>	HT3	<b>0.2755</b>	<b>0.3968</b>	<b>0.4575</b>	<b>0.0243</b>
	EEE	0.2237	0.3740	0.4491	0.0301
<b>C</b>	HT3	<b>0.1847</b>	<b>0.2237</b>	<b>0.2432</b>	<b>0.0078</b>
	EEE	0.1517	0.1858	0.2029	0.0068
<b>G</b>	HT3	<b>0.1313</b>	<b>0.1742</b>	<b>0.1956</b>	<b>0.0086</b>
	EEE	0.1136	0.1407	0.1542	0.0054
<b>H</b>	HT3	<b>0.1751</b>	<b>0.3710</b>	<b>0.4689</b>	<b>0.0392</b>
	EEE	0.1904	0.3515	0.4320	0.0322
<b>I</b>	HT3	<b>0.1796</b>	<b>0.1997</b>	<b>0.2097</b>	<b>0.0040</b>
	EEE	0.1774	0.1881	0.1935	0.0022
<b>Wtd Ave (b)</b>		<b>HT3</b>	<b>0.2091</b>	<b>0.3354</b>	<b>0.3986</b>
		EEE	0.1958	0.3164	0.3767
					0.0253
					0.0241

**Notes:**

- a. The deterioration rate is the rate of increase per 10,000 miles (slope of the regression line).
- b. The weights for the weighted averages are proportional to 1988 sales figures.

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Ethyl Corporation HiTEC 3000 Fleet Testing Program  
0-75k Data Analyzed  
Data Set ETHYL4S2

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----- MODEL=C FUEL=EEE -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.02514	0.02514	36.495	0.0001
Error	106	0.07301	0.00069		
C Total	107	0.09814			
Root MSE		0.02624	R-square	0.2561	
Dep Mean		0.17794	Adj R-sq	0.2491	
C.V.		14.74913			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.151689	0.00502515	30.186	0.0001
MILES	1	0.006831	0.00113080	6.041	0.0001

----- MODEL=C FUEL=HT3 -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.03287	0.03287	24.185	0.0001
Error	108	0.14676	0.00136		
C Total	109	0.17963			
Root MSE		0.03686	R-square	0.1830	
Dep Mean		0.21455	Adj R-sq	0.1754	
C.V.		17.18144			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.184741	0.00700752	26.363	0.0001
MILES	1	0.007797	0.00158536	4.918	0.0001

Ethyl Corporation HiTEC 3000 Fleet Testing Program  
0-75k Data Analyzed  
Data Set ETHYL4S2

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----- MODEL=D FUEL=EEE -----

Model: MODEL1  
Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	1.25892	1.25892	187.801	0.0001
Error	70	0.46924	0.00670		
C Total	71	1.72816			
Root MSE		0.08187	R-square	0.7285	
Dep Mean		0.54672	Adj R-sq	0.7246	
C.V.		14.97555			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.316715	0.01935984	16.359	0.0001
MILES	1	0.059441	0.00433747	13.704	0.0001

----- MODEL=D FUEL=HT3 -----

Model: MODEL1  
Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	1.27689	1.27689	121.032	0.0001
Error	106	1.11830	0.01055		
C Total	107	2.39518			
Root MSE		0.10271	R-square	0.5331	
Dep Mean		0.56744	Adj R-sq	0.5287	
C.V.		18.10099			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.378459	0.01981860	19.096	0.0001
MILES	1	0.048855	0.00444073	11.001	0.0001

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0-75k Data Analyzed  
Data Set ETHYL4S2

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----- MODEL=E FUEL=EEE -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.21924	0.21924	67.987	0.0001
Error	106	0.34182	0.00322		
C Total	107	0.56105			
Root MSE		0.05679	R-square	0.3908	
Dep Mean		0.19240	Adj R-sq	0.3850	
C.V.		29.51500			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.114897	0.01087218	10.568	0.0001
MILES	1	0.020169	0.00244609	8.245	0.0001

----- MODEL=E FUEL=HT3 -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.09414	0.09414	105.901	0.0001
Error	106	0.09422	0.00089		
C Total	107	0.18836			
Root MSE		0.02981	R-square	0.4998	
Dep Mean		0.20256	Adj R-sq	0.4950	
C.V.		14.71845			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.151774	0.00570876	26.586	0.0001
MILES	1	0.013224	0.00128506	10.291	0.0001

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0-75k Data Analyzed  
Data Set ETHYL4S2

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----- MODEL=F FUEL=EEE -----

Model: MODEL1  
Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	1.26397	1.26397	97.534	0.0001
Error	102	1.32184	0.01296		
C Total	103	2.58581			
Root MSE		0.11384	R-square	0.4888	
Dep Mean		0.50588	Adj R-sq	0.4838	
C.V.		22.50287			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.317399	0.02211012	14.355	0.0001
MILES	1	0.050815	0.00514536	9.876	0.0001

----- MODEL=F FUEL=HT3 -----

Model: MODEL1  
Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	1.49715	1.49715	178.470	0.0001
Error	102	0.85566	0.00839		
C Total	103	2.35281			
Root MSE		0.09159	R-square	0.6363	
Dep Mean		0.51639	Adj R-sq	0.6328	
C.V.		17.73654			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.311346	0.01778332	17.508	0.0001
MILES	1	0.055280	0.00413793	13.359	0.0001

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Data Set ETHYL4S2

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----- MODEL=G FUEL=EEE -----

**Model: MODEL1**

**Dependent Variable: HC**

**HC Composite Emissions (g/mi)**

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.01592	0.01592	39.624	0.0001
Error	108	0.04340	0.00040		
C Total	109	0.05932			
Root MSE		0.02005	R-square	0.2684	
Dep Mean		0.13457	Adj R-sq	0.2616	
C.V.		14.89597			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.113621	0.00383821	29.603	0.0001
MILES	1	0.005407	0.00085895	6.295	0.0001

----- MODEL=G FUEL=HT3 -----

**Model: MODEL1**

**Dependent Variable: HC**

**HC Composite Emissions (g/mi)**

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.03965	0.03965	50.782	0.0001
Error	106	0.08277	0.00078		
C Total	107	0.12243			
Root MSE		0.02794	R-square	0.3239	
Dep Mean		0.16427	Adj R-sq	0.3175	
C.V.		17.01115			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.131300	0.00535106	24.537	0.0001
MILES	1	0.008579	0.00120392	7.126	0.0001

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----- MODEL=H FUEL=EEE -----

**Model:** MODEL1

**Dependent Variable:** HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.55864	0.55864	318.696	0.0001
Error	108	0.18931	0.00175		
C Total	109	0.74796			
Root MSE		0.04187	R-square	0.7469	
Dep Mean		0.31413	Adj R-sq	0.7445	
C.V.		13.32825			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.190431	0.00799662	23.814	0.0001
MILES	1	0.032206	0.00180404	17.852	0.0001

----- MODEL=H FUEL=HT3 -----

**Model:** MODEL1

**Dependent Variable:** HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.82624	0.82624	218.288	0.0001
Error	108	0.40879	0.00379		
C Total	109	1.23503			
Root MSE		0.06152	R-square	0.6690	
Dep Mean		0.32511	Adj R-sq	0.6659	
C.V.		18.92385			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.175120	0.01172476	14.936	0.0001
MILES	1	0.039174	0.00265141	14.775	0.0001

Ethyl Corporation HiTEC 3000 Fleet Testing Program  
0-75k Data Analyzed  
Data Set ETHYL4S2

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----- MODEL=I FUEL=EEE -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.00259	0.00259	3.866	0.0518
Error	108	0.07248	0.00067		
C Total	109	0.07508			
Root MSE		0.02591	R-square	0.0346	
Dep Mean		0.18576	Adj R-sq	0.0256	
C.V.		13.94569			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.177362	0.00493565	35.935	0.0001
MILES	1	0.002154	0.00109528	1.966	0.0518

----- MODEL=I FUEL=HT3 -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.00867	0.00867	14.916	0.0002
Error	108	0.06279	0.00058		
C Total	109	0.07146			
Root MSE		0.02411	R-square	0.1214	
Dep Mean		0.19513	Adj R-sq	0.1132	
C.V.		12.35726			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.179552	0.00464219	38.678	0.0001
MILES	1	0.004025	0.00104207	3.862	0.0002

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0-75k Data Analyzed  
Data Set ETHYL4S2

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----- MODEL=T FUEL=EEE -----

Model: MODEL1  
Dependent Variable: HC                    HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.51034	0.51034	217.625	0.0001
Error	112	0.26265	0.00235		
C Total	113	0.77299			
Root MSE		0.04843	R-square	0.6602	
Dep Mean		0.34261	Adj R-sq	0.6572	
C.V.		14.13460			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.223746	0.00924596	24.199	0.0001
MILES	1	0.030051	0.00203710	14.752	0.0001

----- MODEL=T FUEL=HT3 -----

Model: MODEL1  
Dependent Variable: HC                    HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.33239	0.33239	125.077	0.0001
Error	112	0.29764	0.00266		
C Total	113	0.63002			
Root MSE		0.05155	R-square	0.5276	
Dep Mean		0.37148	Adj R-sq	0.5234	
C.V.		13.87698			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.275513	0.00984619	27.982	0.0001
MILES	1	0.024264	0.00216961	11.184	0.0001

## ATTACHMENT D

**Ethyl Corporation HiTEC 3000 Fleet Testing Program  
0-75k Data Analyzed**

**Fitted Regression Lines  
Data Set ETHYL3S2  
Pollutant Hydrocarbons**

<b>Model</b>	<b>Fuel</b>	<b>0 Miles (g/mi)</b>	<b>50k Miles (g/mi)</b>	<b>75k Miles (g/mi)</b>	<b>Deterioration Rate(a) (rate/10,000 mi)</b>
<b>D</b>	HT3	0.3809	0.6264	0.7491	0.0491
	EEE	0.3172	0.6151	0.7640	0.0596
<b>E</b>	HT3	0.1518	0.2178	0.2507	0.0132
	EEE	0.1152	0.2164	0.2670	0.0202
<b>F</b>	HT3	0.3160	0.5871	0.7226	0.0542
	EEE	0.3197	0.5761	0.7043	0.0513
<b>T</b>	HT3	0.2733	0.3992	0.4621	0.0252
	EEE	0.2236	0.3759	0.4520	0.0305
<b>C</b>	HT3	0.1889	0.2233	0.2405	0.0069
	EEE	0.1532	0.1857	0.2020	0.0065
<b>G</b>	HT3	0.1320	0.1713	0.1910	0.0079
	EEE	0.1126	0.1420	0.1568	0.0059
<b>H</b>	HT3	0.1750	0.3700	0.4674	0.0390
	EEE	0.1905	0.3521	0.4329	0.0323
<b>I</b>	HT3	0.1816	0.1998	0.2089	0.0036
	EEE	0.1769	0.1879	0.1934	0.0022
<b>Wtd Ave (b)</b>		HT3 0.2103	0.3352	0.3977	0.0250
		EEE 0.1962	0.3176	0.3783	0.0243

**Notes:**

- a. The deterioration rate is the rate of increase per 10,000 miles (slope of the regression line).
- b. The weights for the weighted averages are proportional to 1988 sales figures.

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Data Set ETHYL3S2

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----- MODEL=C FUEL=EEE -----

**Model: MODEL1**

**Dependent Variable: HC**

**HC Composite Emissions (g/mi)**

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.02322	0.02322	32.035	0.0001
Error	113	0.08191	0.00072		
C Total	114	0.10514			
Root MSE		0.02692	R-square	0.2209	
Dep Mean		0.17787	Adj R-sq	0.2140	
C.V.		15.13702			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.153216	0.00502760	30.475	0.0001
MILES	1	0.006503	0.00114890	5.660	0.0001

----- MODEL=C FUEL=HT3 -----

**Model: MODEL1**

**Dependent Variable: HC**

**HC Composite Emissions (g/mi)**

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.02770	0.02770	20.674	0.0001
Error	129	0.17286	0.00134		
C Total	130	0.20057			
Root MSE		0.03661	R-square	0.1381	
Dep Mean		0.21515	Adj R-sq	0.1314	
C.V.		17.01419			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.188897	0.00660093	28.617	0.0001
MILES	1	0.006882	0.00151348	4.547	0.0001

Ethyl Corporation HiTEC 3000 Fleet Testing Program  
0-75k Data Analyzed  
Data Set ETHYL3S2

2

----- MODEL=D FUEL=EEE -----

Model: MODEL1  
Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	1.26584	1.26584	189.399	0.0001
Error	71	0.47453	0.00668		
C Total	72	1.74037			
Root MSE		0.08175	R-square	0.7273	
Dep Mean		0.54825	Adj R-sq	0.7235	
C.V.		14.91164			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.317216	0.01932276	16.417	0.0001
MILES	1	0.059571	0.00432855	13.762	0.0001

----- MODEL=D FUEL=HT3 -----

Model: MODEL1  
Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	1.29648	1.29648	128.056	0.0001
Error	114	1.15417	0.01012		
C Total	115	2.45064			
Root MSE		0.10062	R-square	0.5290	
Dep Mean		0.57172	Adj R-sq	0.5249	
C.V.		17.59930			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.380907	0.01927734	19.759	0.0001
MILES	1	0.049097	0.00433869	11.316	0.0001

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Data Set ETHYL3S2

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----- MODEL=E FUEL=EEE -----

**Model: MODEL1**

**Dependent Variable: HC**

**HC Composite Emissions (g/mi)**

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.22134	0.22134	69.210	0.0001
Error	108	0.34540	0.00320		
C Total	109	0.56675			
Root MSE		0.05655	R-square	0.3906	
Dep Mean		0.19291	Adj R-sq	0.3849	
C.V.		29.31548			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.115151	0.01079058	10.671	0.0001
MILES	1	0.020244	0.00243342	8.319	0.0001

----- MODEL=E FUEL=HT3 -----

**Model: MODEL1**

**Dependent Variable: HC**

**HC Composite Emissions (g/mi)**

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.09383	0.09383	107.051	0.0001
Error	108	0.09467	0.00088		
C Total	109	0.18850			
Root MSE		0.02961	R-square	0.4978	
Dep Mean		0.20264	Adj R-sq	0.4931	
C.V.		14.61063			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.151832	0.00566387	26.807	0.0001
MILES	1	0.013187	0.00127449	10.347	0.0001

Ethyl Corporation HiTEC 3000 Fleet Testing Program  
0-75k Data Analyzed  
Data Set ETHYL3S2

4

----- MODEL=F FUEL=EEE -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	1.38965	1.38965	102.605	0.0001
Error	113	1.53044	0.01354		
C Total	114	2.92009			
Root MSE		0.11638	R-square	0.4759	
Dep Mean		0.51357	Adj R-sq	0.4713	
C.V.		22.66069			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.319678	0.02200336	14.529	0.0001
MILES	1	0.051288	0.00506327	10.129	0.0001

----- MODEL=F FUEL=HT3 -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	1.56082	1.56082	191.987	0.0001
Error	111	0.90241	0.00813		
C Total	112	2.46323			
Root MSE		0.09017	R-square	0.6336	
Dep Mean		0.52245	Adj R-sq	0.6303	
C.V.		17.25816			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.316044	0.01714225	18.437	0.0001
MILES	1	0.054210	0.00391237	13.856	0.0001

Systems Applications  
November 4, 1991

Ethyl Corporation HiTEC 3000 Fleet Testing Program  
0-75k Data Analyzed  
Data Set ETHYL3S2

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----- MODEL=G FUEL=EEE -----

Model: MODEL1  
Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.02049	0.02049	40.294	0.0001
Error	117	0.05950	0.00051		
C Total	118	0.08000			
Root MSE		0.02255	R-square	0.2562	
Dep Mean		0.13603	Adj R-sq	0.2498	
C.V.		16.57818			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.112599	0.00423117	26.612	0.0001
MILES	1	0.005889	0.00092767	6.348	0.0001

----- MODEL=G FUEL=HT3 -----

Model: MODEL1  
Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.03524	0.03524	39.926	0.0001
Error	114	0.10061	0.00088		
C Total	115	0.13585			
Root MSE		0.02971	R-square	0.2594	
Dep Mean		0.16328	Adj R-sq	0.2529	
C.V.		18.19464			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.131960	0.00567191	23.265	0.0001
MILES	1	0.007868	0.00124519	6.319	0.0001

Systems Applications  
November 4, 1991

Ethyl Corporation HiTEC 3000 Fleet Testing Program  
0-75k Data Analyzed  
Data Set ETHYL3S2

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----- MODEL=H FUEL=EEE -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.60201	0.60201	323.240	0.0001
Error	123	0.22908	0.00186		
C Total	124	0.83109			
Root MSE		0.04316	R-square	0.7244	
Dep Mean		0.31683	Adj R-sq	0.7221	
C.V.		13.62105			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.190504	0.00801691	23.763	0.0001
MILES	1	0.032316	0.00179742	17.979	0.0001

----- MODEL=H FUEL=HT3 -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.84951	0.84951	232.744	0.0001
Error	121	0.44165	0.00365		
C Total	122	1.29116			
Root MSE		0.06042	R-square	0.6579	
Dep Mean		0.32568	Adj R-sq	0.6551	
C.V.		18.55026			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.175032	0.01127777	15.520	0.0001
MILES	1	0.038987	0.00255550	15.256	0.0001

Ethyl Corporation HiTEC 3000 Fleet Testing Program  
0-75k Data Analyzed  
Data Set ETHYL3S2

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----- MODEL=I FUEL=EEE -----

**Model: MODEL1**

**Dependent Variable: HC**

**HC Composite Emissions (g/mi)**

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.00272	0.00272	4.224	0.0422
Error	113	0.07275	0.00064		
C Total	114	0.07547			
Root MSE		0.02537	R-square	0.0360	
Dep Mean		0.18541	Adj R-sq	0.0275	
C.V.		13.68529			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.176927	0.00475705	37.193	0.0001
MILES	1	0.002191	0.00106602	2.055	0.0422

----- MODEL=I FUEL=HT3 -----

**Model: MODEL1**

**Dependent Variable: HC**

**HC Composite Emissions (g/mi)**

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.00742	0.00742	12.560	0.0006
Error	118	0.06975	0.00059		
C Total	119	0.07717			
Root MSE		0.02431	R-square	0.0962	
Dep Mean		0.19538	Adj R-sq	0.0885	
C.V.		12.44321			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.181597	0.00447860	40.548	0.0001
MILES	1	0.003644	0.00102820	3.544	0.0006

Ethyl Corporation HiTEC 3000 Fleet Testing Program  
0-75k Data Analyzed  
Data Set ETHYL3S2

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----- MODEL=T FUEL=EEE -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

## Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.53949	0.53949	226.419	0.0001
Error	117	0.27878	0.00238		
C Total	118	0.81827			
Root MSE		0.04881	R-square	0.6593	
Dep Mean		0.34347	Adj R-sq	0.6564	
C.V.		14.21172			

## Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.223569	0.00913880	24.464	0.0001
MILES	1	0.030460	0.00202427	15.047	0.0001

----- MODEL=T FUEL=HT3 -----

Model: MODEL1

Dependent Variable: HC

HC Composite Emissions (g/mi)

## Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	0.37764	0.37764	136.452	0.0001
Error	119	0.32934	0.00277		
C Total	120	0.70697			
Root MSE		0.05261	R-square	0.5342	
Dep Mean		0.37109	Adj R-sq	0.5302	
C.V.		14.17641			

## Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	0.273316	0.00964020	28.352	0.0001
MILES	1	0.025170	0.00215470	11.681	0.0001

Systems Applications  
November 4, 1991

## VEHICLE-TO-VEHICLE EMISSION VARIABILITY

In its October 4, 1991 submission to EPA, Ethyl claims that the vehicle-to-vehicle emissions variability from the Explorer vehicle is high, and that the MMT additive is not the critical variable. We disagree with both statements. First, the variability in emission data seen on the clear-fueled Explorer vehicles at 55,000 miles from 0.15 gpm for vehicle #305 and 0.35 gpm for vehicle #307 is not unlike the variability seen from clear-fueled vehicles in Ethyl's fleet, nor is it unlike the variability seen from the fleet of thousands of 50,000-mile Ford-EPA certification vehicles. At the 50,000-mile test, Ethyl's clear-fueled Ford Escort demonstrated test variability from 0.13 gpm (vehicle E4) to 0.32 gpm (vehicle E2) (includes catalyst efficiency test data). Second, the larger variability in test results at 55,000 for MMT-fueled Ford vehicles from 0.17 gpm for vehicle #308 to 0.55 gpm for vehicle #304 are a result of the different rates of MMT contamination of the engines and emission control devices on these vehicles. Vehicle #304 was adversely affected more quickly than vehicle #308. However, the HC levels from these two vehicles after 100,000 miles with MMT were more in line. Vehicle #308 had an average HC level of 0.66 gpm and vehicle #304, 0.89 gpm at 100,000 miles. This variability is similar to that from some Ethyl test vehicles. The difference (delta) between these two Ford vehicles of 0.38 gpm HC at 55,000 miles is very similar to the difference Ethyl's Dodge test vehicles demonstrated. These Dodge test vehicles have a delta of 0.38 gpm between one test on vehicle D4 (0.55 gpm) and one test on vehicle D5 (0.91 gpm). As such, for Ethyl to question the representativeness of Ford test data based on test variability would also apply to its data. Again, these differences or variabilities are not uncommon to test data generated by Ford for other test programs which are orders of magnitude greater than the Ethyl test data.

Further testing on MMT vehicle #308 with new fuel injectors installed after 100,000 miles lowered the HC level from 0.66 gpm to 0.28 gpm. The HC levels of clear vehicle #305 with old and new injectors did not show deterioration. This clearly demonstrates how MMT has contaminated the fuel injectors causing poor fuel-air distribution to the cylinders resulting in high HC levels. An analysis of the deposits on the fuel injectors removed from vehicle #308 indicates the presence of MMT. The effect of MMT on engines and emission control devices appear to be erratic. The Explorer vehicles have higher feedgas HC levels as a result of MMT indicating fuel injector contamination, whereas the Escort vehicles had greater contamination of their emission control devices resulting in higher HC levels. The mileage intervals at which point MMT causes the greatest increase in HC levels varies from vehicle type to type. However, after 100,000 miles, both Escort and Explorer MMT-fueled vehicles demonstrated much higher HC levels than the clear-fueled vehicles. It is believed that the Explorers, after 100,000 miles, demonstrated the greater HC increase than the Escorts because of the much higher consumption of MMT on the Explorers. Also, it is believed that the greater variability in HC levels on the MMT-fueled Explorers after 50,000 miles is a result of the erratic effect MMT has on the performance of fuel injectors. It is clear from the test data from vehicle #308 that new fuel injectors substantially improved HC levels. If Ford had changed fuel injectors on these vehicles after 50,000 miles, the adverse effect of MMT would have been masked at higher mileage points. Changing fuel injectors at 50,000 miles is clearly the wrong thing to do.

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F.V. AND CROSSOVERS

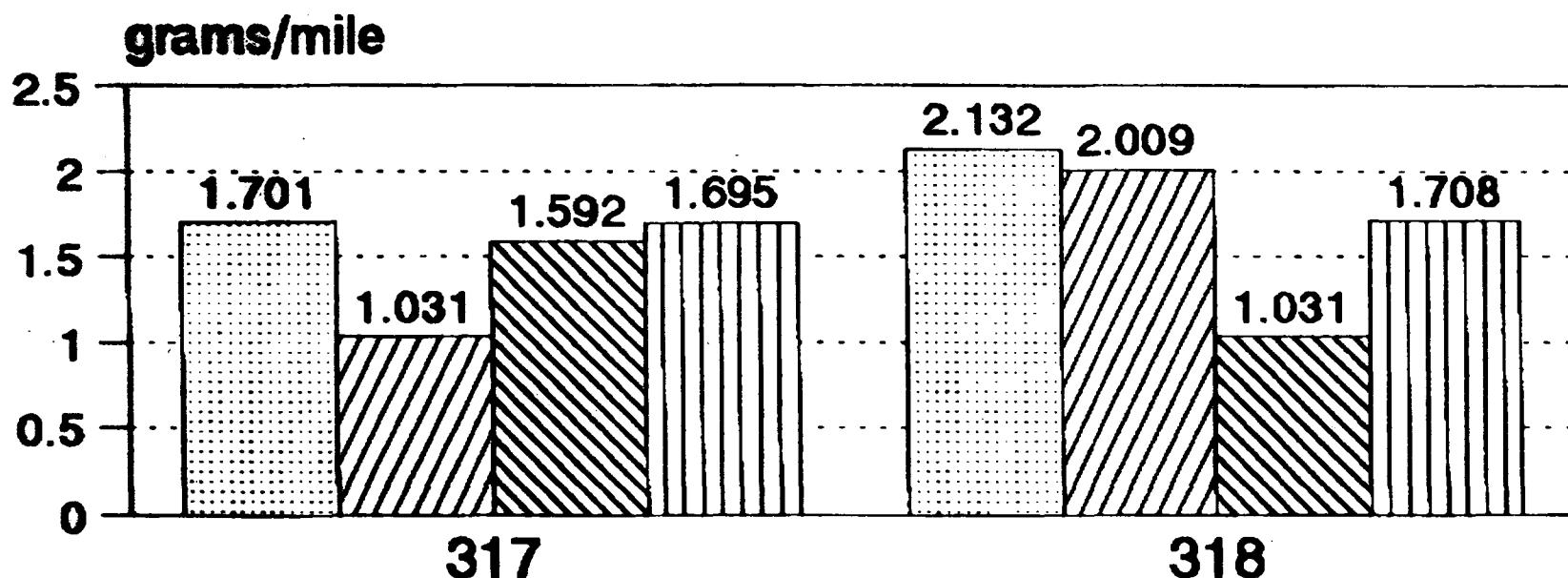
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- 2 -

The variability of Ethyl's emission test data within model types at 50,000 miles with MMT varied from a low of 0.02 gpm HC for Model I to as high as 0.38 gpm HC for Model D. For the clear-fueled models, the variability within model types ranged from 0.05 gpm HC for Model G to 0.27 gpm for Model F. From these data, Ethyl averaged together all the MMT results and compared it to all the clear results. It is not good engineering practice to average together data with 0.02 variability and data which has 0.38 variability. From these averages, Ethyl concludes that MMT causes an "increase in average HC emissions of between 0.01 to 0.018 gpm, depending upon how the data are interpreted." From the large variability within model types of up to 0.38 gpm HC with MMT fuel and up to 0.27 gpm HC with clear fuel, it is wrong to attempt to conclude the effect of MMT is 0.01 to 0.018 gpm. The wide variability observed does not allow for this conclusion. The effect of MMT could be much greater, as it could be masked by test variability.

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# HC Feedgas Emissions Escort Fleet



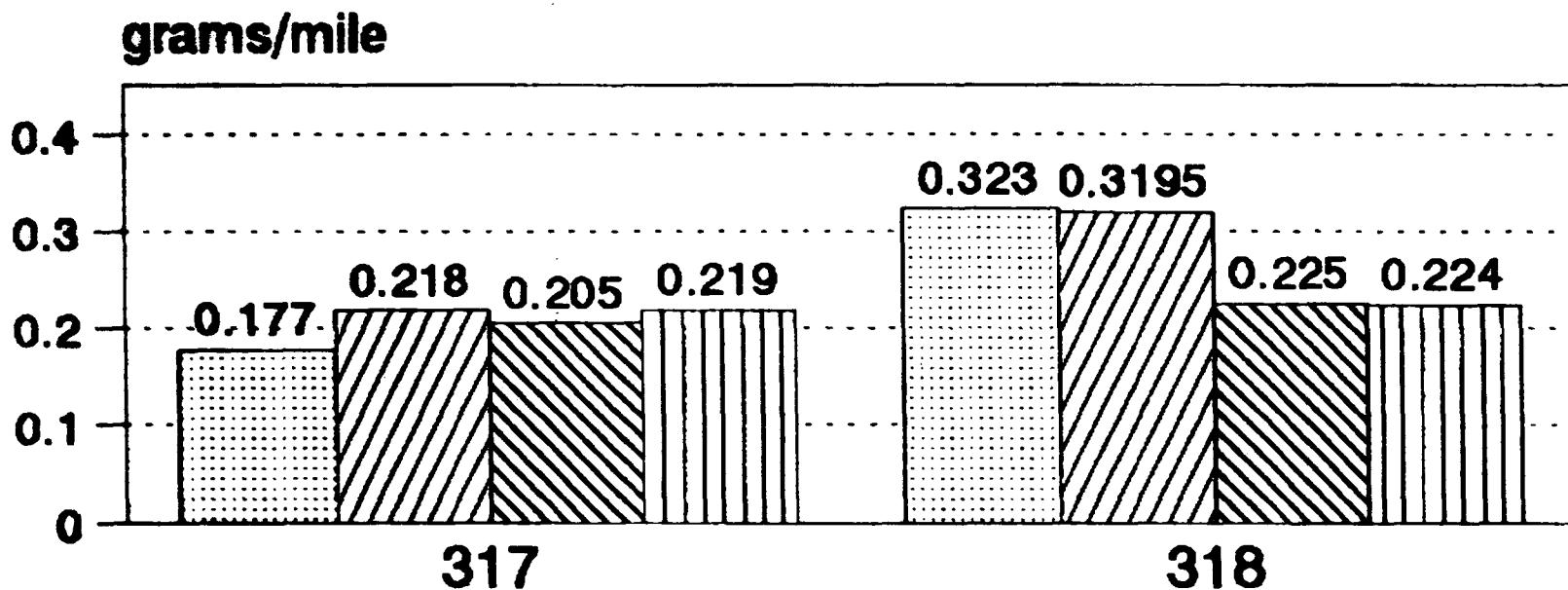
Vehicle Modification

- Baseline    / HEGO    ■ Catalyst    □ HEGO & Catalyst

317- Non-MMT Fuel

318- MMT Fuel

# HC Tailpipe Emissions Escort Fleet



Vehicle Modification

- Baseline    ▨ HEGO    ▨ Catalyst    ▨ HEGO & Catalyst

317- Non-MMT Fuel

318- MMT Fuel

# EXCHANGE FUEL INJECTORS

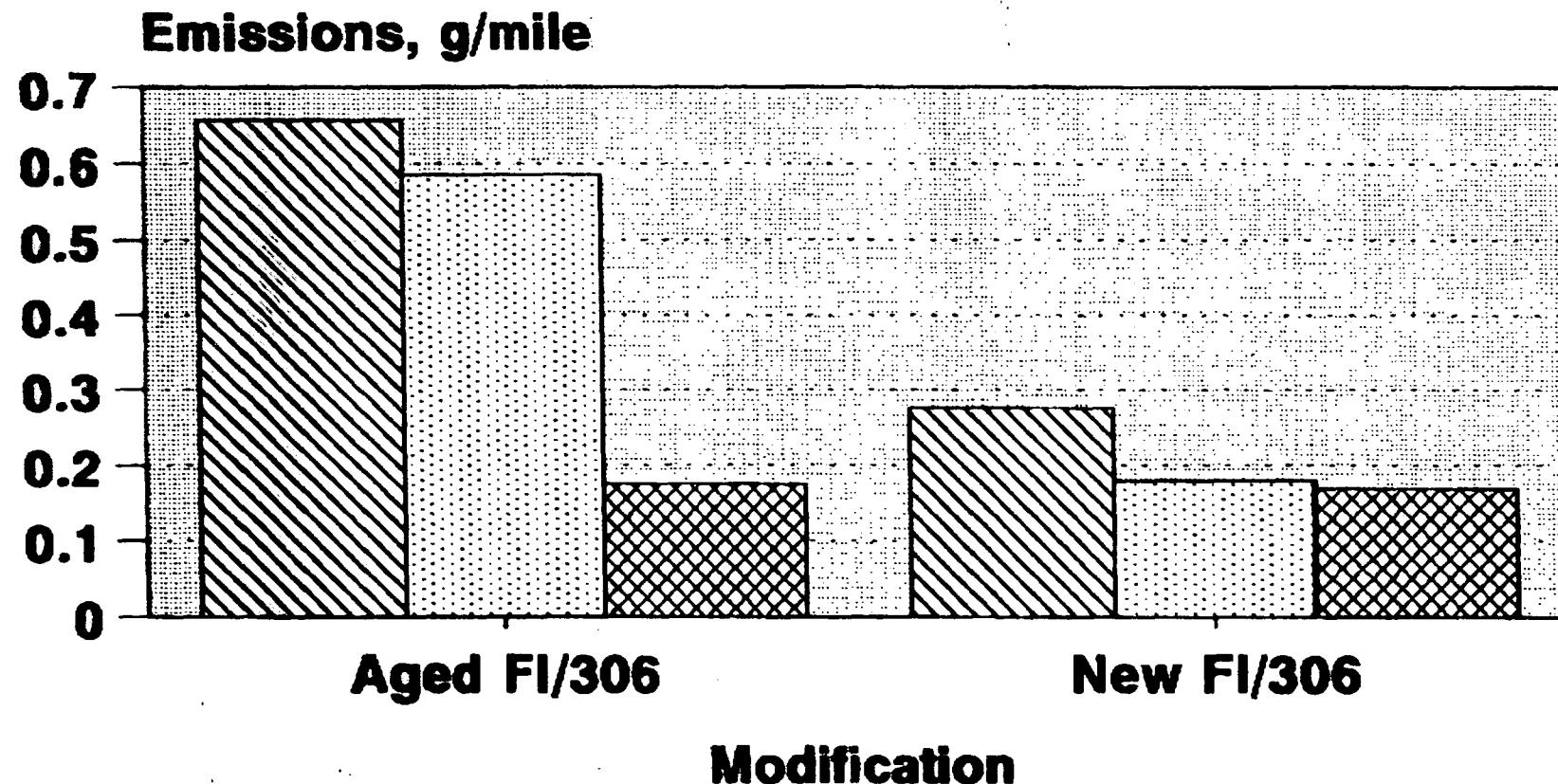
## Vehicle #306

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F.E. AND EMISSIONS

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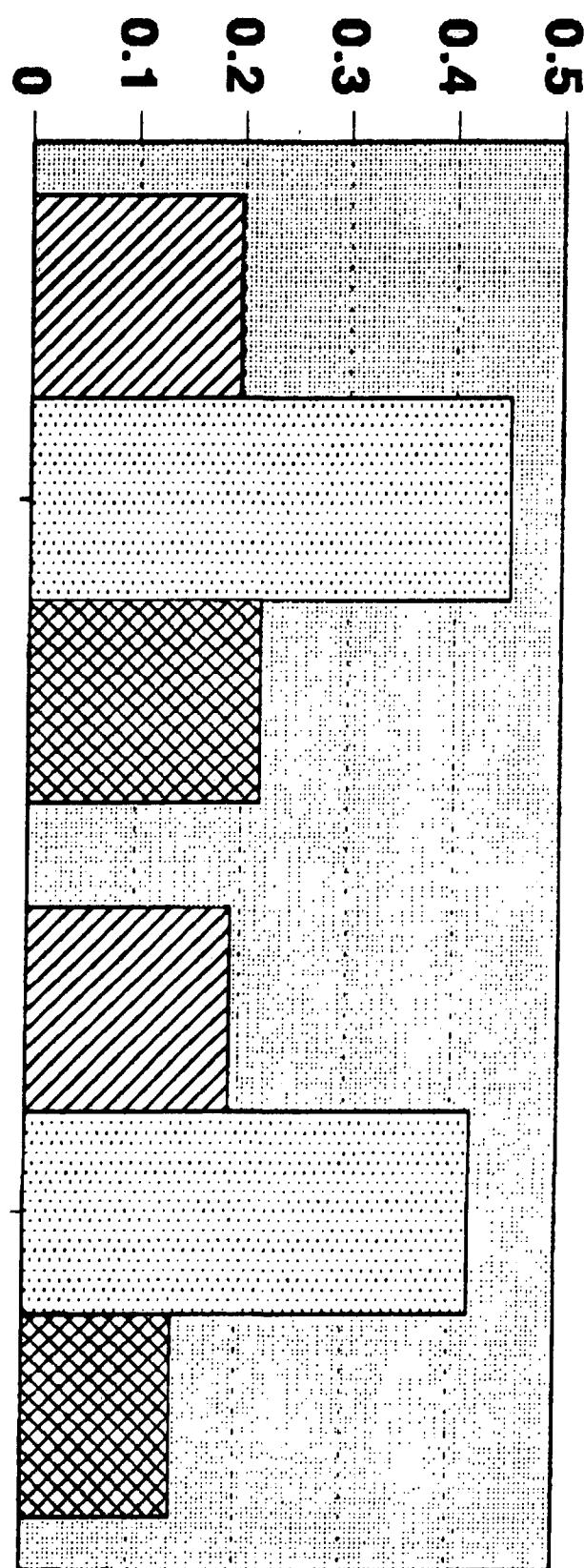
**Aged FI @105,000 miles  
100,000 miles MMT Exposure**

HC CO x10 NOx

# EXCHANGE FUEL INJECTORS

Vehicle #305

Emissions, g/mile



Modification

■ HC   ■ CO x10   ■ NOx

Aged FI @105,000 miles  
100,000 miles MMT Exposure

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F.O. AND EMISSIONS

P.03703

Table 12

Vehicle Number	Odometer (miles)	Correlation Cell				Particulate Cell			
		HC g/mi	CO g/mi	NO <sub>x</sub> g/mi	No of Tests	HC g/mi	CO g/mi	NO <sub>x</sub> g/mi	No of Tests
315	5,000	0.092 ± .011	0.832 ± .073	0.298 ± .030	6	0.113	0.741	0.190	1
	20,000	0.146 ± .029	1.397 ± .421	0.327 ± .053	6	0.183 ± .006	0.937 ± .017	0.302 ± .031	2
	55,000	0.184 ± .020	1.944 ± .338	0.384 ± .034	6	0.195 ± .021	1.203 ± .014	0.333 ± .025	2
	85,000	n.a.	n.a.	n.a.	n.a.	0.277 ± .017	2.242 ± .130	0.397 ± .016	2
316	105,000	0.174 ± .015	2.095 ± .357	0.447 ± .023	6	0.266 ± .057	2.122 ± .170	0.463 ± .039	3
	5,000	0.088 ± .009	0.840 ± .155	0.249 ± .029	6	0.178	1.373	0.264	1
	20,000	0.161 ± .019	1.488 ± .210	0.303 ± .026	6	0.211 ± .043	1.326 ± .340	0.280 ± .061	4
	55,000	0.332 ± .096	2.116 ± .550	0.386 ± .047	6	0.239 ± .002	1.290 ± .031	0.452 ± .039	2
317	85,000	n.a.	n.a.	n.a.	n.a.	0.354 ± .004	2.052 ± .156	0.553 ± .006	2
	105,000	0.312 ± .027	2.325 ± .408	0.448 ± .025	6	0.368 ± .048	1.727 ± .050	0.452 ± .030	3
	55,000	0.189 ± .020	1.708 ± .219	0.396 ± .035	6	0.171 ± .016	1.132 ± .087	0.429 ± .023	2
	105,000	0.177 ± .018	2.433 ± .467	0.521 ± .030	6	0.210 ± .006	2.130 ± .015	0.574 ± .022	3
318	55,000	0.327 ± .019	1.687 ± .139	0.462 ± .019	6	0.451 ± .011	2.050	0.479 ± .017	2
	105,000	0.323 ± .041	2.911 ± .604	0.509 ± .024	6	0.355 ± .008	2.175 ± .043	0.538 ± .011	3

Note: standard deviations are shown; the correlation and particulate cells used EEE and durability fuels, respectively.

Table 11

Vehicle Number	Odometer (miles)	Correlation Cell				Particulate Cell			
		HC g/mi	CO g/mi	NO <sub>x</sub> g/mi	No of Tests	HC g/mi	CO g/mi	NO <sub>x</sub> g/mi	No of Tests
304	55,000	0.548 ± .061	3.242 ± .206	0.200 ± .008	6	0.467 ± .059	3.513 ± .753	0.207 ± .007	2
	105,000	0.887 ± .101	5.572 ± .305	0.221 ± .011	6	0.880 ± .012	6.166 ± .279	0.287 ± .022	2
305	5,000	0.120 ± .008	1.840 ± .184	0.118 ± .015	6	0.126	1.898	0.139	1
	20,000	0.119 ± .004	2.228 ± .146	0.141 ± .012	6	0.113	1.974	0.190	1
	55,000	0.154 ± .005	3.596 ± .252	0.131 ± .008	6	0.152 ± .017	3.383 ± .305	0.190 ± .009	3
	85,000	0.168 ± .012	4.151 ± .098	0.163 ± .014	4	0.187 ± .017	n.a.	0.161 ± .003	3
	105,000	0.197 ± .007	4.512 ± .260	0.217 ± .013	6	0.214 ± .001	4.918 ± .417	0.226 ± .004	2
306	5,000	0.142 ± .010	1.812 ± .113	0.106 ± .009	6	0.147	1.735	0.123	1
	20,000	0.172 ± .015	2.279 ± .141	0.078 ± .009	6	0.176	2.775	0.153	1
	55,000	0.173 ± .016	1.734 ± .125	0.314 ± .056	6	0.188 ± .023	2.058 ± .227	0.334 ± .008	2
	85,000	n.a.	n.a.	n.a.	n.a.	0.672 ± .044	5.834 ± .204	0.213 ± .015	2
	105,000	0.656 ± .020	5.862 ± .065	0.175 ± .013	6	0.666 ± .078	5.729 ± .080	0.186 ± .017	3
307	55,000	0.353 ± .034	4.709 ± .377	0.178 ± .019	6	0.306 ± .028	4.315 ± .325	0.156 ± .003	2
	105,000	0.383 ± .008	6.186 ± .195	0.143 ± .015	6	0.429 ± .048	7.168 ± .820	0.151 ± .014	3

Note: standard deviations are shown; the correlation and particulate cells used EEE and durability fuels, respectively.

## FACSIMILE TRANSMISSION

AUTOMOTIVE EMISSIONS  
& FUEL ECONOMY OFFICEENVIRONMENTAL AND  
SAFETY ENGINEERINGDate: 11/15 Time: \_\_\_\_\_NUMBER OF SHEETS TO BE TRANSMITTED  
(INCLUDING THIS ONE): 3TO: DAVE KORTUMFROM: TOM LASLEY

Attached are the particulate emission data  
three 105,000 on our vehicles. This  
includes the 85K data on veh. 306  
which Ethyl may want. Our particulate  
emission report thru 55K also contained  
additional thermal emission data at 201K  
and 55K which has not been used in  
our analysis as it was not at a correlated  
cell.

TELEPHONE: 313/\_\_\_\_\_

FAX: 313/845-5175

The American Ford 243 West Hamden  
Detroit, Michigan 48211-1000

# ATTACHMENT 3

## AGENDA

### Meeting between Ethyl Corporation and U.S. EPA Regarding the Waiver Application for HITEC® 3000 November 14, 1991

1. Comments About Ford Test Protocol
  - Ford failed to follow standard EPA certification test protocol requirements
    - No unscheduled maintenance emission tests
    - No 12 hour soak
    - No vehicle emission prep
  - Submission of all available emission test data
  - The impact of electronic engine control software problems
  - The impact of inconsistent vehicle maintenance
2. Specific Response to Automobile Company Comments
  - Ford's functional analysis
  - GM alternative explanation for NOx reductions in the 48-car test program
  - Ford's "Pulsator" analysis and GM's high-speed load testing
    - Catalyst light-off test results on Ethyl test cars at 75,000 miles
    - Catalyst surface area analysis on Ethyl test cars at 75,000 miles
    - High-speed Corvette test results
  - Maintenance of the vehicles in Ethyl's 48-car test program was documented in Ethyl's waiver submission
  - Ford's claim about the impact of including the 151 "extra test" data points is incorrect based on statistical analysis
3. The Results of Additional Emission Testing and Analyses
4. The Burden of Persuasion under § 211(f)(4)

## THE BURDEN OF PERSUASION UNDER § 211(f)(4)

1. The Applicant's Initial Burden and the Burden on Other Interested Parties -- The applicant's initial burden under § 211(f)(4) is no different than the burden confronting any petitioner who seeks official action from the government. Just as plaintiffs in civil lawsuits bear the burden of establishing an initial (or "prima facie") case in support of their allegations, fuel additive waiver applicants must initially present a case that use of a fuel additive will not cause or contribute to the failure of emission control devices to meet applicable emission standards.

- Upon presentation of a prima facie case in support of a waiver application, the burden shifts to others to refute or critique the case by producing equally competent evidence. This does not mean that the ultimate burden of persuasion under § 211(f)(4) is shifted to others, but rather, that those opposing a waiver application must present competent evidence sufficient to create an issue of fact to be determined by the fact finder.
- Where an applicant has established a prima facie case and critical comments have been submitted by others, the Agency's decision on the application must turn upon what the preponderance (i.e., greater weight) of the competent evidence in the record shows.
- The preponderance of the evidence determination involves two steps. First, the Agency must determine whether individual pieces of evidence are credible and worthy of consideration. Second, the Agency must determine what the weight of the competent evidence shows.

2. Ethyl Has Satisfied the Initial Burden of Producing Evidence under § 211(f)(4) -- A review of prior fuel additive waiver proceedings before the Agency makes clear that the results of Ethyl's comprehensive 48-car test program, together with the large amount of collateral test results submitted by Ethyl, is more than adequate to establish the applicant's initial case under § 211(f)(4). The Agency has granted fuel additive waivers based on far less testing (e.g., 15% MTBE based on only ten test vehicles, Octamix based on seven test vehicles). Having satisfied the applicant's initial burden, Ethyl has shifted the burden to others to produce equally competent evidence in opposition to the waiver.

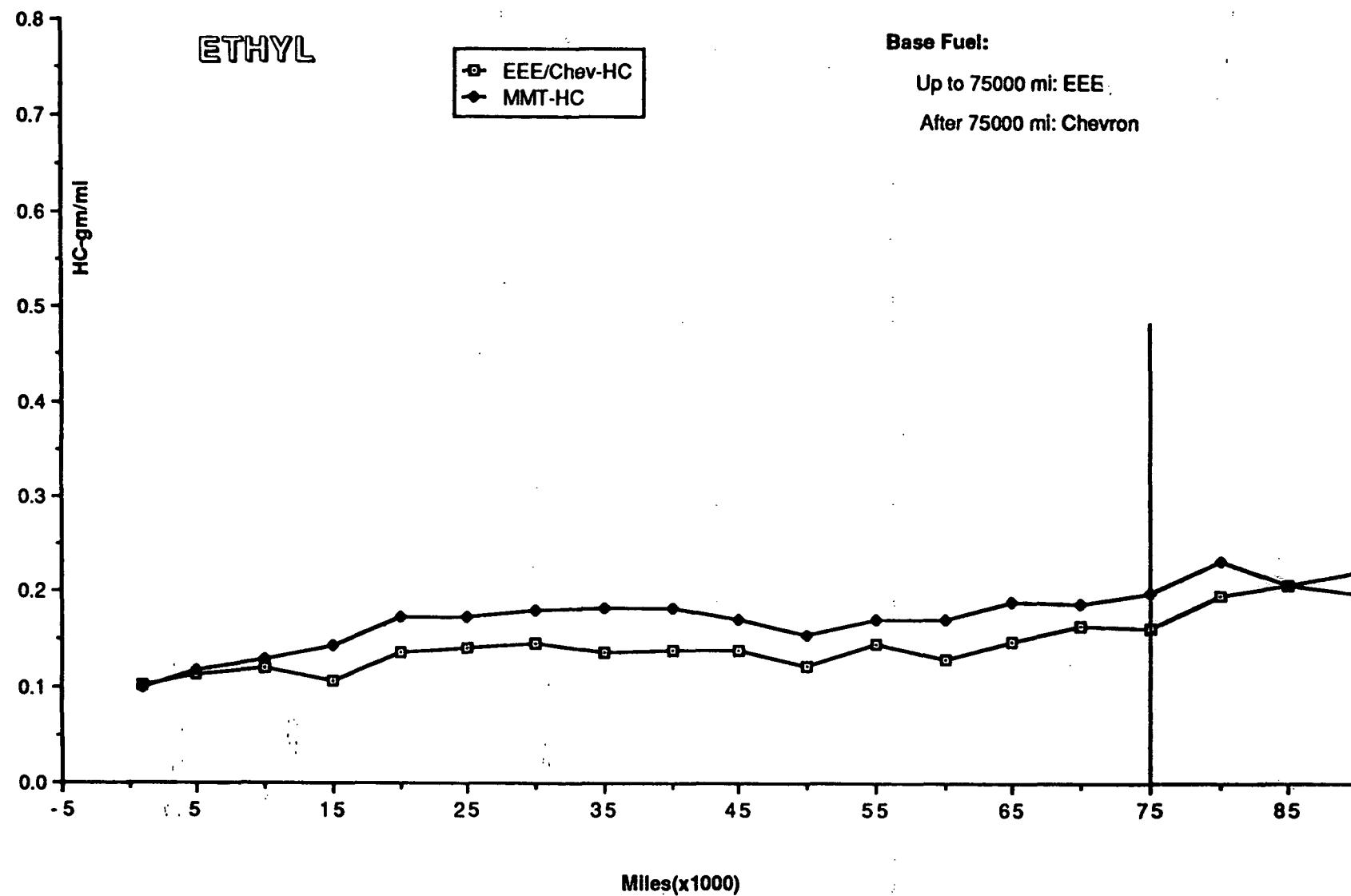
3. The Mere Fact that Evidence in Opposition to Ethyl's Waiver Has Been Submitted by Others Does Not Mean Ethyl Has Failed to Satisfy its Burden -- The automobile industry has consistently submitted evidence in opposition to new fuel additives, including the results of emission testing. This has not stopped the Agency from approving fuel additive waiver applications for, among others, tertiary butyl alcohol ("TBA"), methyl tertiary butyl alcohol ("MTBE"), or methanol/TBA.

4. Ethyl Has Satisfied the Ultimate Burden of Persuasion under § 211(f)(4) -- No matter what approach the Agency takes with respect to the record before it, Ethyl should prevail.

- If the Agency agrees with Ethyl that the Ford test data are not competent and therefore are not entitled to any weight in this proceeding, then Ethyl's comprehensive case in support of the Additive stands unrebutted, and Ethyl should prevail.
- If the Agency determines that the Ford test data are at least minimally competent and therefore entitled to some consideration in this proceeding, Ethyl should prevail by virtue of the far greater weight of the evidence in support of the waiver. The Ford test data (and the theories Ford develops based on its data to explain the apparent difference in emission results between the Ford and Ethyl test programs) are entitled to little, if any, weight in this proceeding given
  - (i) the unrepresentative nature of Ford's eight car test "fleet,"
  - (ii) the limited number of emission tests conducted by Ford on the test vehicles,

- (iii) Ford's failure to retain independent laboratories to conduct the testing, and
- (iv) the serious unanswered questions about Ford's test protocol design and implementation and uncertainty regarding Ford's submission of all relevant emission data for its test vehicles.
- If the Agency determines that the Ford test data are entitled to be weighed equally with the Ethyl data, Ethyl should prevail based on the preponderance of the evidence standard as applied by the Agency in past waiver application proceedings.
- When confronted by different sets of apparently competent data concerning the effects of an additive, the Agency has evaluated the weight of the evidence by applying its standard statistical analyses to data sets comprised of all available tailpipe emission data, regardless of the source of the data or differences in test protocols used to generate that data. The Agency adopted this approach for its decisions approving use of TBA and MTBE, and denying use of HiTEC 3000 (then MMT) in 1978.
- Applying this approach to HiTEC 3000, SAI concludes that, based on all available emission data (including the Ford data), use of the Additive will not cause or contribute to the failure of emission control systems to meet applicable emission standards.

### HC Emissions(Avg)-Model G(Buick 2.5L)



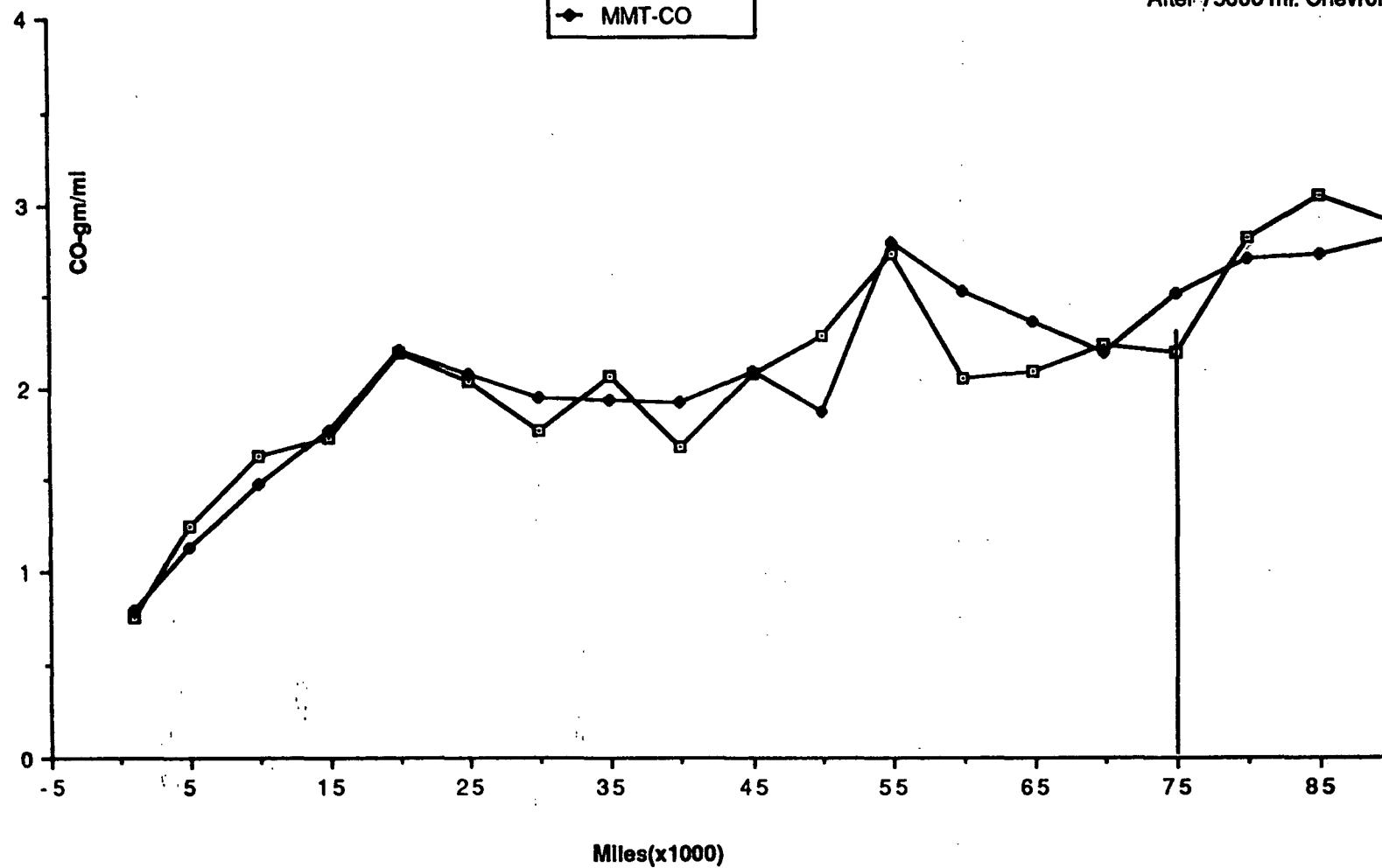
### CO Emissions(Avg)-Model G(Buick 2.5L)

ETHYL

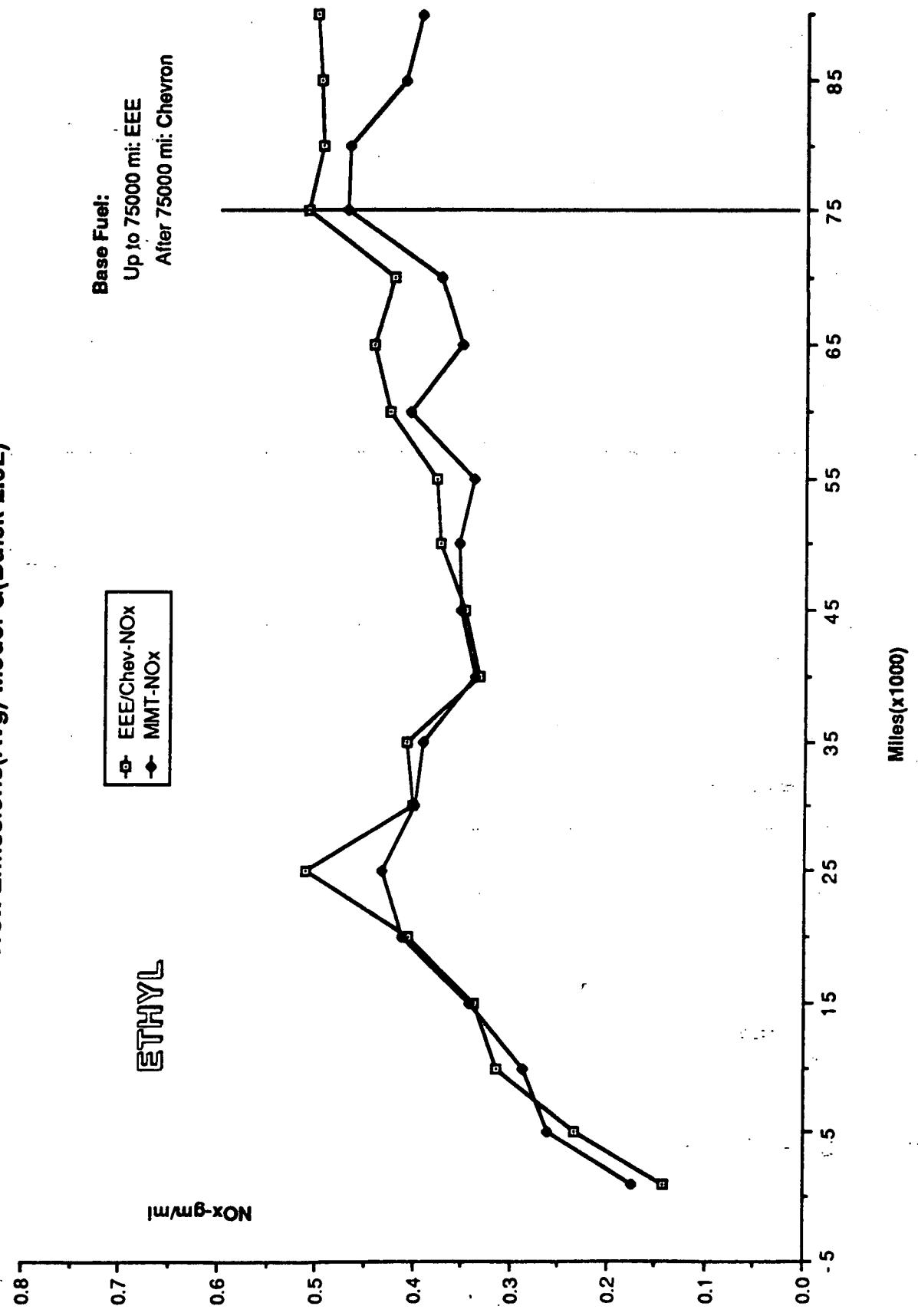
EEE/Chev-CO  
MMT-CO

Base Fuel:

Up to 75000 mi: EEE  
After 75000 mi: Chevron



### NO<sub>x</sub> Emissions(Avg)-Model G(Buick 2.5L)



Wed, Nov 13, 1991 1:54 PM

Emissions-Model G

Miles(x1000)	EEE/Chev-HC	MMT-HC	EEE/Chev-CO	MMT-CO	EEE/Chev-NOx	MMT-NOx	Remarks
1	1	0.101	0.100	0.758	0.789	0.142	0.173 Base Fuel:
2	5	0.113	0.117	1.243	1.131	0.234	0.261 Up to 75000
3	10	0.120	0.130	1.631	1.469	0.313	0.287 miles: EEE.
4	15	0.106	0.142	1.732	1.773	0.338	0.341 After: Chevron
5	20	0.136	0.172	2.191	2.207	0.405	0.412 commercial
6	25	0.140	0.173	2.033	2.077	0.511	0.432
7	30	0.146	0.179	1.770	1.947	0.400	0.399
8	35	0.136	0.182	2.058	1.939	0.408	0.391
9	40	0.139	0.182	1.682	1.919	0.334	0.338
10	45	0.138	0.171	2.075	2.091	0.347	0.353
11	50	0.123	0.153	2.282	1.873	0.373	0.354
12	55	0.146	0.169	2.737	2.794	0.377	0.339
13	60	0.130	0.169	2.053	2.525	0.427	0.406
14	65	0.148	0.189	2.084	2.356	0.443	0.353
15	70	0.164	0.186	2.234	2.190	0.422	0.373
16	75	0.161	0.197	2.198	2.511	0.512	0.471
17	80	0.194	0.232	2.818	2.706	0.497	0.469
18	85	0.206	0.207	3.054	2.732	0.499	0.411
19	90	0.197	0.219	2.907	2.825	0.503	0.394

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## Additional Statistical Analyses of Hydrocarbons with "Extra" Tests Added

- Data analyzed: Data set ETHYL4S2 plus 131 "extra" tests
- Analyses performed: Linear regression to 50K and 75K miles
- Results: Predicted hydrocarbon differences between HiTEC 3000 and EEE are decreased

# Ethyl Fleet 75,000-mile Data Sets

Number and description of excluded tests

<u>Data Set</u>	<u>No. tests</u>	<u>Description</u>
ETHYL0S	1	D3A Accident
ETHYL1S	164	Zero-mile tests
ETHYL2S	136	Invalid tests
ETHYL3S	339	Unscheduled maint.
ETHYL4S	151	"Extra" tests

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# Cause and Contribute Analysis of Ethyl Vehicle Test Data

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<u>Data set</u>	<u>No. tests</u>	<u>HC</u>	<u>CO</u>	<u>NOx</u>
ETHYL4S	1712	Pass	Pass	Pass
ETHYL1S	2502	Pass	Pass	Pass

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## Methodology for Analysis of Ethyl and Ford HiTEC 3000 Test Results

- 10 Model groups: 8 Ethyl and 2 Ford
- Use Ethyl data set ETHYL4S2  
(same as used in original analysis)
- Ford data exclusions following same protocol  
as used for Ethyl data exclusions
  - Explorer 306: 7 tests before unsched. maint.
  - Escort 318: Use post-accident tests - 10K miles

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## STATISTICAL ANALYSIS OF HYDROCARBONS

### Ethyl and Ford Data Combined

- All Adverse Effects Test Results are Unchanged
- All Cause or Contribute Tests are Passed
  - First 50K Miles
    - 50K standard except 100K for Explorer
    - Ethyl data to 50K, Ford data to 55K
    - Both linear and quadratic regression
  - Full Mileage Accumulation
    - 75K standard except 100K for Explorer
    - Ethyl data to 75K, Ford data to 105K
    - Quadratic regression

Evaluation of HiTEC 3000 Effect on Catalysts

11-14-91

Conversion Efficiencies

Conversion efficiencies for all of the 48 cars in the Ethyl fleet test were determined for CO, NOX, and HC. Catalysts of cars run for 50,000 and 75,000 on HiTEC 3000 performed as well as and, in some instances, better than catalysts from clear fuel cars.

In addition to determining conversion efficiencies of catalysts on the cars, Ethyl also removed catalysts from one-half of the 48-car fleet (12 pairs of catalysts). These 24 catalysts were evaluated on a slave engine to determine conversion efficiencies and catalyst light-off times. The slave engine results confirmed the findings from evaluations made on cars. HiTEC 3000 did not result in adverse effects on catalysts.

Light-Off Time

The times required for the catalysts to reach 50 percent conversion efficiencies were also determined on the 24 catalysts by Southwest Research Institute. The mean light-off times for CO, NOX, and HC for all clear and HiTEC 3000 catalysts were

Seconds to 50% Conversion Efficiency

	HC	CO	NOX
Clear Fuel	19.0	27.1	19.1
HiTEC 3000 Fuel	17.0	27.6	17.4

HiTEC 3000 fuel did not adversely affect light-off times and trended towards shorter (better) times for HC and NOX.

Surface Area

The surface areas of the 24 catalysts are summarized below. Each catalyst core is divided into one-third segments, inlet third, middle third, and outlet third. The grand mean surface areas for the inlet segments are slightly higher for the HiTEC 3000 catalysts while the middle and outlet segments are approximately the same.

Surface Area (m<sup>2</sup>/gram)

	Inlet Third	Middle Third	Outlet Third
Clear Fuel	17.1	19.7	21.8
HiTEC 3000 Fuel	19.1	20.4	21.4

## RESPONSE TO SPECIFIC AUTO INDUSTRY COMMENTS

1. Ford's Functional Analysis -- The underlying hypothesis of Ford's functional analysis is that all variables are controlled for except for the effect of HiTEC 3000 on emission control systems. A review of the Ford data makes clear that Ford's functional analysis is subject to operating variables (and measurement variability) in addition to the type of fuel used in the vehicle.

- *The Ford data show significant differences in clear-fuel conversion efficiencies at the start of the test and a marked difference in catalyst deterioration over the duration of the test program -- and the Additive cannot be the explanation. See Tables 1, 2 and 3. Ford has not shown that its functional analysis accounts for this "normal" variability in emission control system performance.*
- *Clear-fuel Escort No. 315, with a baseline NOx conversion efficiency of 85.1 percent, shows a conversion efficiency of only 81.6 percent with the EGO sensor and catalyst from the Additive-fueled Escort No. 316. The baseline NOx conversion efficiency for vehicle 316, however, is 85.2 percent. If the hypothesis underlying Ford's functional analysis was true, vehicle 315's conversion efficiency should have been 85.2 percent, or 3.6 percentage points higher than the measured value.*
- *Clear fuel vehicle 305 had a HC conversion of 89.5 after interchanging EGO sensors and catalysts with Additive-fueled vehicle 306 even though the baseline HC conversion efficiency of vehicle 306 was only 80.5. Similarly, use of clear fuel catalysts and EGO sensors on Additive-fueled vehicles 306 and 318 generated conversion efficiencies for NOx and CO, respectively, far lower than the baseline conversion efficiencies generated on these vehicles using EGO sensors and catalysts exposed to the Additive. See Table 4.*
- *Vehicle pairs 315/316 and 305/306 exhibit higher CO conversion efficiencies after the components are interchanged than either baseline conversion efficiency (76 and 75.2 percent vs. 74.8 and 72.6 percent, respectively, for vehicles 315/316 and 71.3 and 84.8 percent vs. 71.3 and 63 percent, respectively, for vehicles 305/306). See Table 4.*

2. GM's Alternative Explanation for NOx Reductions -- GM asserts that a reduction in engine-out NOx emissions of approximately 0.1 gpm at 50,000 miles in the GM test vehicles explains the reduction in NOx tailpipe emissions seen in the 48-car test fleet. GM is plainly in error because:

- *GM fails to take into account the effect of the catalyst on any difference in absolute engine out emissions. Assuming fuel related NOx engine out emissions of 1.84 and 1.74 gpm, respectively, as claimed by GM, and a conversion efficiency of 75 percent, the resulting difference in tailpipe NOx emissions would be approximately 0.025 gpm [(1.84 x 0.75) - (1.74 x 0.75)]. This difference is well less than half the average difference in NOx emissions shown in the 48-car test program at 50,000 miles and confirms what Ethyl has maintained all along -- i.e., the lower NOx emissions are explained, at least in part, by enhanced catalytic conversion efficiency for NOx emissions.*

3. Ford's "Pulsator" Analysis and GM's High-speed Load Testing -- Both Ford and GM have conducted very limited laboratory tests of catalysts on the basis of which they assert use of the Additive will adversely affect catalyst operation. These tests are entitled to little, if any, weight given the vast amount of in-use data on catalyst operation which do not show any catalyst impairment.

- *The results of catalyst light-off testing shows that the light-off of catalysts exposed to the Additive is as good or better than clear fuel catalysts.*
- *The results of catalyst surface area analysis shows that the surface areas of catalysts exposed to the Additive is the same or higher, on average, than clear fuel catalysts.*

- *Real world testing of Corvettes equipped with the same close-coupled catalysts subjected to the GM tests using a high speed driving cycle (100 mph constant speed) show no differences in back pressure. The clear fuel back pressure measurements were 16.6, 16.5 and 15.2 inches of mercury for the zero, 25,000 and 50,000 mile intervals, respectively. The corresponding Additive-fueled measurements were 16.9, 17.6 and 16.8 for the same mileage intervals. Emissions for the two Corvettes remained comparable.*

4. Questions about Maintenance of the Vehicles in Ethyl's 48-Car Test Fleet -- Any concerns about the nature of the maintenance accorded vehicles in Ethyl's 48-car test fleet are totally without merit. Ethyl's test protocol required vehicles to be maintained in accordance with normal vehicle maintenance schedules. Unscheduled maintenance was performed only on the basis of driveability problems, never on the basis of emission test results. Appendix one of Ethyl's May 9, 1991 waiver application describes Ethyl's test protocol in detail and provides a complete history of the scheduled and unscheduled maintenance for each test vehicle.

5. Ford's Claim about the Impact of Including the 151 "Extra Test" Data Points Is Incorrect -- Ford asserts that inclusion of the 151 "extra tests" dropped from SAI's original statistical analysis of the 48-car test fleet data would change the results of the analysis as it relates to HC emissions. This is not the case.

- *Statistical analysis of all of the data generated as part of the 48-car test program (i.e., no data excluded) does not change any of the conclusions of the original SAI statistical analysis.*
- *SAI states that inclusion of the 151 "extra tests" is statistically unsound.*
- *Statistical analysis, consistent with that conducted in Ethyl's waiver application, shows that inclusion of the 151 data points reduces the differences in HC emissions at both 50,000 and 75,000 miles between the clear and Additive-fueled vehicles.*

**TABLE 2. CO CONVERSION EFFICIENCY BASED ON FORD TEST DATA.****FORD ESCORTS**

Mileage	CLEAR		HiTEC 3000	
	#315	#317	#316	#318
5K	88.6	88.6	89.0	85.6
20K	82.6	83.5	81.6	79.4
55K	76.0	78.9	75.1	81.4
105K	74.8	71.7	72.6	69.7

**FORD EXPLORERS**

Mileage	CLEAR		HiTEC 3000	
	#305	#307	#304	#306
5K	89.1	85.8	85.7	89.0
20K	85.8	83.0	79.6	85.3
55K	77.1	69.8	79.6	88.1
85K	74.4	72.1	64.1	--
105K	71.1	62.2	66.0	63

**TABLE 3. NO<sub>x</sub> CONVERSION EFFICIENCY BASED ON FORD TEST DATA****FORD ESCORTS**

Mileage	CLEAR		HiTEC 3000	
	#315	#317	#316	#318
5K	90.6	90.4	92.3	90.7
20K	90.0	89.6	90.4	88.9
55K	86.9	86.0	87.1	85.7
105K	85.1	82.4	85.2	83.7

**FORD EXPLORERS**

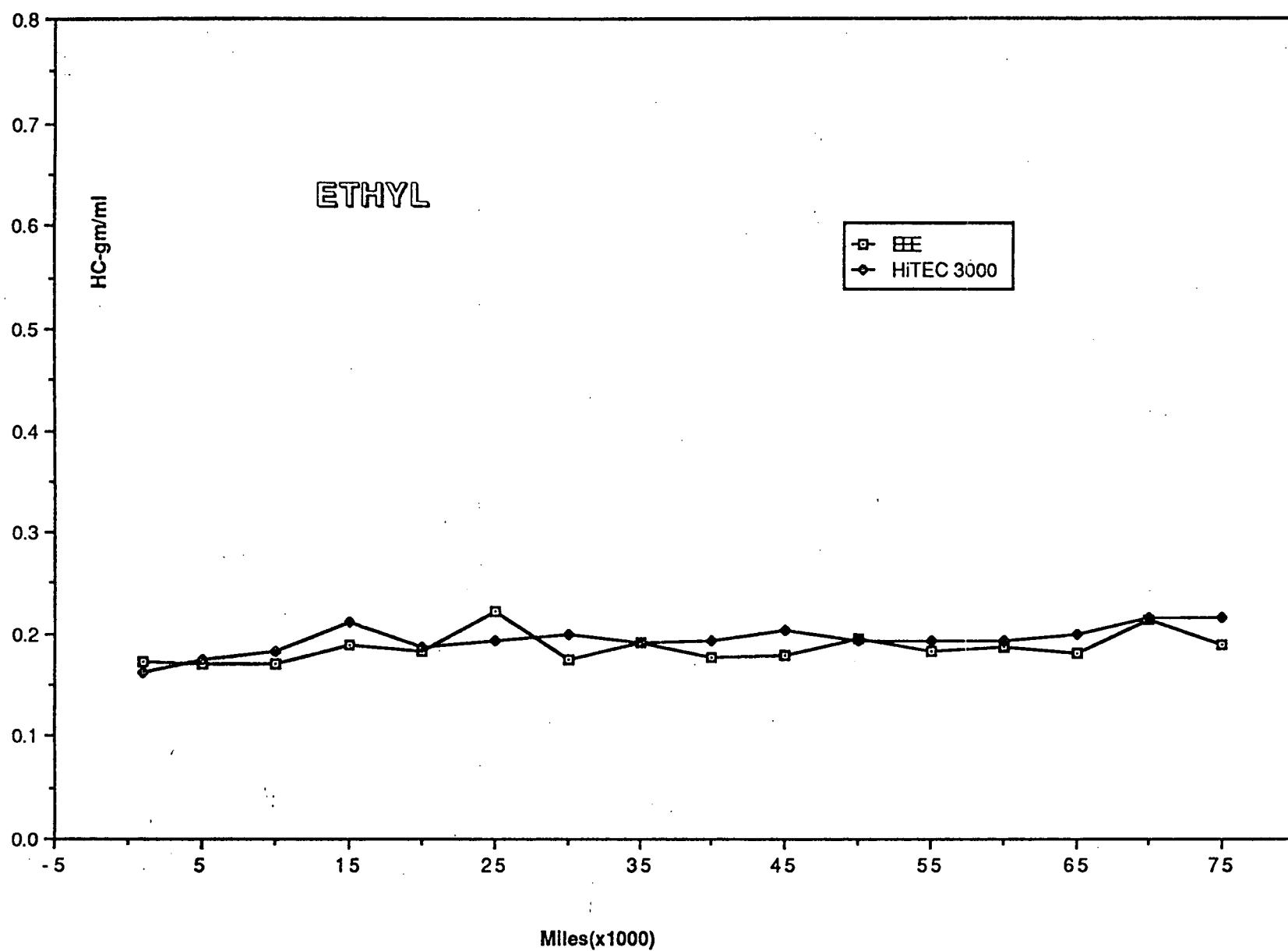
Mileage	CLEAR		HiTEC 3000	
	#305	#307	#304	#306
5K	96.6	94.4	93.2	96.2
20K	95.5	94.8	92.5	96.8
55K	93.8	88.5	95.8	77.5
85K	93.1	87.9	88.3	--
105K	91.0	91.9	86.8	89.8

TABLE 4. CONVERSION EFFICIENCIES FROM FORD'S FUNCTIONAL ANALYSIS

Vehicle	HC		CO		NOx	
	Baseline	Interchanged EGO & Cat.	Baseline	Interchanged EGO & Cat.	Baseline	Interchanged EGO & Cat.
No. 315	91.0	86.3	74.8	76.0	85.1	81.6
No. 316	84.2	90.6	72.6	75.2	85.2	85.9
No. 317	89.6	N.R.	71.7	N.R.	82.4	N.R.
No. 318	84.8	86.9	69.7	62.5	83.7	80.3
No. 305	89.9	89.5	71.1	71.3	91.0	92.2
No. 306	80.5	91.8	63.0	84.8	89.8	80.2
No. 307	83.0	77.0	62.2	61.1	91.9	91.9
No. 304	76.0	N.R.	66.0	N.R.	86.8	N.R.

N.R. Data necessary to compute conversion efficiencies not reported in Ford's submission to EPA.

### HC Emissions(Avg)-Model I(Buick 3.8L)



## Emissions-Model 1

Miles(x1000)	EEE-HC	MMT-HC	EEE-CO	MMT-CO	EEE-NOx	MMT-NOx
1	0.173	0.162	1.610	1.545	0.214	0.240
2	0.170	0.174	1.830	1.745	0.369	0.277
3	0.171	0.183	2.175	2.357	0.402	0.420
4	0.190	0.212	2.308	2.522	0.415	0.363
5	0.184	0.187	2.428	2.404	0.462	0.448
6	0.223	0.193	2.573	2.533	0.431	0.450
7	0.175	0.200	2.384	2.335	0.416	0.367
8	0.191	0.181	2.428	2.362	0.361	0.354
9	0.176	0.194	2.372	2.432	0.413	0.398
10	0.178	0.203	2.702	2.383	0.437	0.365
11	0.195	0.194	2.631	2.543	0.463	0.391
12	0.183	0.184	2.632	2.249	0.493	0.326
13	0.187	0.194	2.668	2.289	0.464	0.310
14	0.181	0.200	2.289	2.376	0.551	0.333
15	0.214	0.216	3.504	2.775	0.680	0.469
16	0.190	0.218	2.668	2.568	0.582	0.436
17						
18						
19						
20						
21						
22						

## GENERAL COMMENTS ABOUT THE FORD TEST PROTOCOL

1. Ford did not conduct its vehicle test program in accordance with standard EPA certification test procedures. This alone invalidates the Ford test data.

- *In emission test programs run under EPA certification protocols, anytime unscheduled maintenance is performed, emission tests must be performed both before and after the maintenance. Ford failed to conduct these tests. (See Attachment 1).*
- *The data sheets supplied by Ford make clear that Ford did not conduct its emission tests in accordance with the standard certification protocol developed by EPA.*
  - *In many cases, Ford conducted more than one emission test per day which is generally not possible because of the 12-hour soak component of the certification test procedure. This suggests that the 12-hour soak was not conducted.*
  - *Odometer readings from test to test vary by as little as 11 miles, the length of the FTP. This also means that Ford failed to "prep" the cars as required by EPA test procedures prior to emission testing.*

2. Ford has not supplied to the Agency all emission data from its limited test program.

- *Ford has not supplied any emission data for vehicle 306 (an Additive-fueled Explorer) between 55,000 miles and 105,000 miles. Yet the maintenance log for vehicle 306 indicates that it was taken to Ford at 84,940 miles "for emission testing." Similar notations occur for vehicles 315 (a clear fuel Escort) and 316 (an Additive-fueled Escort) after 84,940 miles.*
- *These notations are inconsistent with Ford's representation at the public hearing that it "did not exclude any of the data that was run on these vehicles." (Transcript at 33). Given the small number of test intervals reflected in the Ford test data, the emission results for an additional test interval could substantially affect the conclusions to be drawn from the Ford test data.*
- *As suggested in Ford's September 4, 1991 submission, Ford conducted testing in a particulate test cell up to 105,000 miles. Ford has not submitted this data in its entirety to the Agency.*

3. The data supplied by Ford indicates that Ford's test vehicles exhibited electronic engine control software problems.

- *The maintenance logs for Ford's test vehicles show that five of Ford's eight test vehicles (one Escort and all four prototype Explorers) experienced "electronic engine control software" problems over the course of the Ford test program. The vast*

majority of the "check engine light illuminations" occurred in the prototype Explorers (17 of 18).

- The vehicle which exhibited this problem earliest and to the most significant degree (vehicle 304 at approximately 17,000 miles) also had the "highest" HC emissions of any Explorer, and the steepest increase in HC emissions from 5000 miles to 20,000 miles. Given this fact, it is not enough for Ford to assert, without more, that "engineering evaluations" showed no "malfunctions." The real issue is not malfunctioning as Ford would have the Agency believe, but rather, whether the problem contributed in any way to differences in vehicle emissions.

**4. The maintenance logs for Ford's test vehicles show inconsistent treatment of the test vehicles.**

- Ford made an ignition system component change in all of the Explorers at approximately 5300 miles, which differed from vehicle to vehicle, some apparently receiving production components while others received prototype components. Ford has not established that these differences in maintenance of the vehicles had no effect on vehicle emissions.